Compaq Smart Array 5300 Controller

User Guide

Part Number 135606-004

May 2002 (Fourth Edition)

COMPAQ

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Contents

About This Guide

This guide provides step-by-step instructions for installation, and reference information for operation, troubleshooting, and future upgrades for the Compaq Smart Array 5300 Controller.

⚠ Important Safety Information

Before installing this product, read the *Important Safety Information* document provided.

Symbols on Equipment

The following symbols may be placed on equipment to indicate the presence of potentially hazardous conditions:

WARNING: This symbol, in conjunction with any of the following symbols, indicates the presence of a potential hazard. The potential for injury exists if warnings are not observed. Consult your documentation for specific details.

This symbol indicates the presence of hazardous energy circuits or electric shock hazards. Refer all servicing to qualified personnel.

WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure. Refer all maintenance, upgrades, and servicing to qualified personnel.

This symbol indicates the presence of electric shock hazards. The area contains no user or field serviceable parts. Do not open for any reason.

WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure

This symbol on an RJ-45 receptacle indicates a network interface connection.

WARNING: To reduce the risk of electric shock, fire, or damage to the equipment, do not plug telephone or telecommunications connectors into this receptacle.

This symbol indicates the presence of a hot surface or hot component. If this surface is contacted, the potential for injury exists.

WARNING: To reduce the risk of injury from a hot component, allow the surface to cool before touching.

These symbols, on power supplies or systems, indicate that the equipment is supplied by multiple sources of power.

WARNING: To reduce the risk of injury from electric shock, remove all power cords to completely disconnect power from the system.

Weight in kg
Weight in lb

This symbol indicates that the component exceeds the recommended weight for one individual to handle safely.

WARNING: To reduce the risk of personal injury or damage to the equipment, observe local occupational health and safety requirements and guidelines for manual material handling.

Symbols in Text

These symbols may be found in the text of this guide. They have the following meanings.

WARNING: Text set off in this manner indicates that failure to follow directions in the warning could result in bodily harm or loss of life.

CAUTION: Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

IMPORTANT: Text set off in this manner presents clarifying information or specific instructions.

NOTE: Text set off in this manner presents commentary, sidelights, or interesting points of information.

Text Conventions

This document uses the following conventions:

- *Italic type* is used for complete titles of published guides or variables. Variables include information that varies in system output, in command lines, and in command parameters in text.
- **Bold type** is used for emphasis, for onscreen interface components (window titles, menu names and selections, button and icon names, and so on), and for keyboard keys.
- `Monospace typeface` is used for command lines, code examples, screen displays, error messages, and user input.
- Sans serif typeface is used for uniform resource locators (URLs).

Related Documents

For additional information on the topics covered in this guide, refer to the following documentation:

- *Compaq Array Configuration Utility XE User Guide* (on the software CD provided with the server, or downloadable from the Compaq website)
- *Compaq Servers Troubleshooting Guide* (on the Documentation CD for the server)

- *Compaq ROM-Based Setup Utility User Guide* (on the Documentation CD for the server, or downloadable from the Compaq website)

Getting Help

If you have a problem and have exhausted the information in this guide, you can get further information and other help in the following locations.

Compaq Technical Support

In North America, call the Compaq Technical Support Phone Center at 1-800-OK-COMPAQ. This service is available 24 hours a day, 7 days a week. For continuous quality improvement, calls may be recorded or monitored. Outside North America, call the nearest Compaq Technical Support Phone Center. Telephone numbers for worldwide Technical Support Centers are listed on the Compaq website, www.compaq.com.

Be sure to have the following information available before you call Compaq:

- Technical support registration number (if applicable)
- Product serial number
- Product model name and number
- Applicable error messages
- Add-on boards or hardware
- Third-party hardware or software
- Operating system type and revision level

Compaq Website

The Compaq website has information on this product as well as the latest drivers and flash ROM images. You can access the Compaq website at www.compaq.com.

Compaq Authorized Reseller

For the name of your nearest Compaq authorized reseller:

- In the United States, call 1-800-345-1518.
- In Canada, call 1-800-263-5868.
- Elsewhere, see the Compaq website for locations and telephone numbers.

Reader's Comments

Compaq welcomes your comments on this guide. Please send your comments and suggestions by email to `ServerDocumentation@compaq.com`.

1

Board Components and Features

The Compaq Smart Array 5300 Series of controllers comprises two models, the 5302 and the 5304. Model 5302 has two Wide Ultra3 SCSI channels and 128 MB of cache; model 5304 has four Wide Ultra3 SCSI channels and 256 MB of cache. You can upgrade the 5302 model to have four channels, 256 MB of cache, or both, by means of the appropriate option kits.

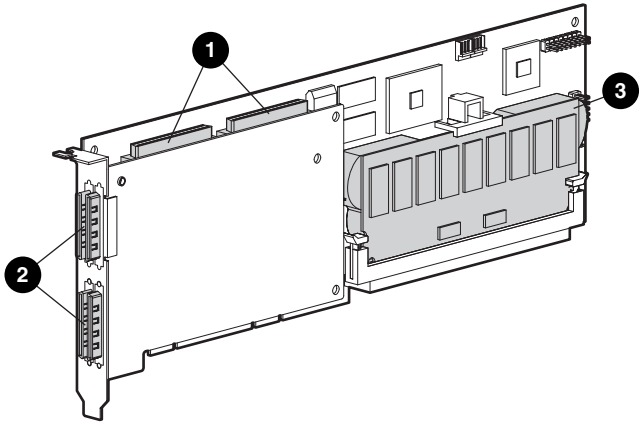


Figure 1-1: Smart Array 5304 Controller

Item	Description
1	Two internal 68-pin Wide SCSI connectors (port 1 nearer the bracket, port 2 nearer the board center)
2	Four external (VHDCI) connectors (ports 1 and 3 nearer the main board)
3	Array accelerator cache

NOTE: On both controller models, ports 1 and 2 each have two connectors (one internal and one external). However, only one connector can be used per port at any given time. Ports 3 and 4 (available on the 5304) can be used only for external drives.

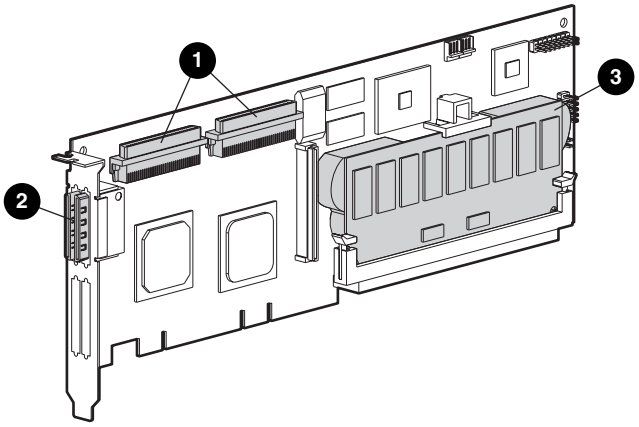


Figure 1-2: Smart Array 5302 Controller

Item	Description
1	Two internal 68-pin Wide SCSI connectors (port 1 nearer the bracket, port 2 nearer the board center)
2	Two external (VHDCI) connectors (port 1 nearer the board)
3	Array accelerator cache

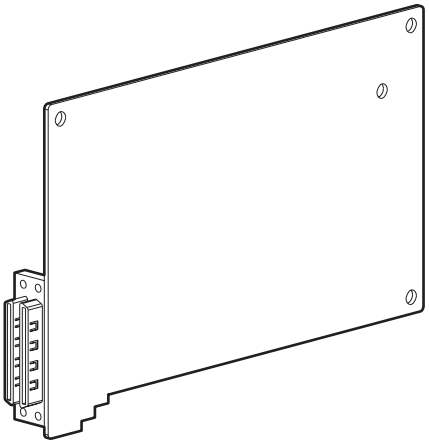


Figure 1-3: Two- to four-channel adapter upgrade option

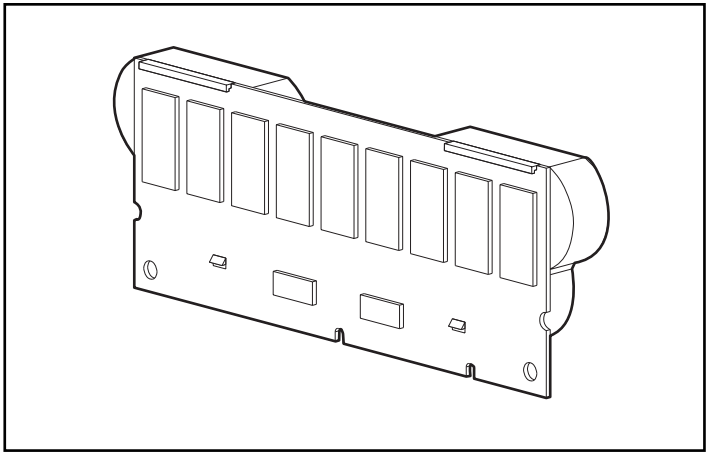


Figure 1-4: Array accelerator cache with batteries

For details of the controller board specifications, refer to Appendix C.

Overview of Controller Features

- Two or four Wide Ultra3 SCSI channels, supporting up to 56 drives (4 channels, 14 drives per channel)
- Support for Microsoft Windows 2000, Windows NT 4.0, Linux, Novell NetWare 5.x, and NetWare 6 operating systems
- Support for the Compaq Universal Hot Plug Tape Drive, with storage capacity up to 100 GB and LVD transfer rates up to 12 MB per second
- Support for the Compaq *StorageWorks*™ SAN Access Module
- Backward compatibility with Wide Ultra2 devices
- Removable array accelerator
- 64-bit, 66-MHz PCI system interface
- Other features supported:
  - — RAID fault-tolerance (0, 1+0, 5, ADG) (refer to Chapter 9 for instructions on enabling RAID ADG)
  - — Online RAID migration between any two levels
  - — Online array capacity expansion
  - — Online logical drive capacity extension
  - — Hot-pluggable hard drives and tape drives
  - — Drive movement
  - — Adjustable stripe size
  - — Performance monitoring through *Compaq Insight Manager*™
  - — S.M.A.R.T. hard drives
  - — Drive pre-failure notification
  - — Multiple online spares per array
  - — Tagged command queuing
  - — Background initialization
  - — Multiple logical drives per array

Overview of Array Accelerator Features

The array accelerator is a high performance, battery-backed, 100-MHz SDRAM DIMM cache module.

Array controllers use cache to store read data from the hard drives. The system can later access this read data. The controller firmware uses the read-ahead and most recently used caching algorithms.

Array controllers also use cache to complete drive write operations more quickly. This use of the cache has further performance benefits:

- If the system requires data that still resides in write cache, the controller delivers this data from the cache. This process is quicker than delivering the data from a drive.
- If the system writes new data to the same location, the controller overwrites the cache contents. This eliminates a drive write operation.
- If the system performs a RAID 1 procedure, the controller gets mirrored data from the cache instead of from host memory.
- If the system performs a RAID 5 procedure, the write cache collects enough data blocks from several write accesses to carry out a full stripe write to the hard drives. This operation eliminates the need to calculate and update parity information each time that a data block is written to the drive.

With a battery-backed cache available, the array controller can complete the following operations more rapidly:

- **Array capacity expansion—**the expansion of a logical drive volume to include more hard drives
- **Stripe size migration—**the adjustment of the size of data blocks within a stripe, done to improve performance
- **RAID level migration—**the adjustment of RAID level to improve the fault tolerance of the array

For each of these operations, data has to be reorganized among hard drives, and must be saved to non-volatile storage during the operation. (For further details of these operations, refer to Chapter 7, Appendix D, and Appendix E.) Without battery-backed cache, the data can only be stored at empty locations within the drive array, so these operations cannot occur at all if the array is full.

If the array controller or server fails before cached data can be stored on the array, the array accelerator and its integrated batteries may be removed from one array controller and installed on another controller of the same type. Any data in the array accelerator that has not been written to the hard drive will be transferred to the other array controller.

Other features of the array accelerator include:

- Cache capacity of 96-MB or 224-MB (32 MB of the cache is used for transfer buffer)
- Adjustable read/write ratio (usually set during array configuration as described in Chapter 7, but can be changed at any time)
- Error checking and correcting (ECC) memory, providing single-bit data correction

Sometimes, the Automatic Performance Tuning feature disables the array accelerator. You can also disable the array accelerator manually through the Array Configuration Utility (refer to Chapter 7 for details).

Batteries

The array accelerator cache has two rechargeable and replaceable NiMH battery packs. If the array accelerator is removed from the array controller, the battery packs maintain any cached data on the array accelerator for up to four continuous days.

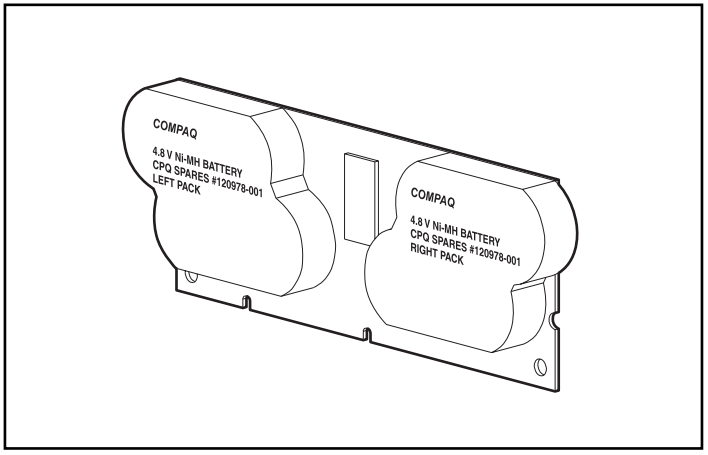


Figure 1-5: Battery packs

This data protection (and the time limit) also applies if an equipment failure or power outage occurs. When power is restored to the system, an initialization process writes the preserved data to the hard drives.

The batteries are continuously recharged using a trickle-charging process whenever the system power is on. Under normal operating conditions, a battery pack lasts for three years before replacement is necessary.

IMPORTANT: The batteries on a new array controller may have a low charge when the controller board is first installed. In this case, a Power-On Self-Test (POST) message 1794 is displayed when the server is powered up (refer to Appendix G), indicating that the array accelerator is temporarily disabled. No action is required on your part, since the internal circuitry automatically recharges the batteries and enables the cache. The recharge process takes less than four hours. The array controller will function properly during this time, although without the performance advantage of the array accelerator. When the batteries are charged to an acceptable capacity, the array accelerator is automatically enabled.

For battery replacement instructions, refer to Chapter 9.

PCI System Interface

Smart Array 5300 controllers interface to the server through a high-performance 64-bit PCI bus that:

- Runs at 66 MHz
- Provides a high-speed path (up to 528 MB/s) between the system board and the controller
- Includes two parity protection signals

The Smart Array 5300 Controller is a PCI Bus Master device conforming to Rev. 2.2 of the PCI Local Bus Specification. As a bus master device, it takes control of the PCI bus during high-speed transfers, freeing the system processor to handle application processing or other types of tasks.

For maximum performance, Compaq recommends that you use only 66-MHz devices on any given 66-MHz PCI bus. Combining 66-MHz and 33-MHz devices on a PCI bus will decrease the overall bandwidth to 33-MHz speeds.

SCSI Support

The Smart Array 5300 Controller supports drives that conform to Wide Ultra3 and Wide Ultra2 standards. Although Wide Ultra2 devices operate at a different maximum speed from Wide Ultra3 devices, operating speeds are unaffected if they are connected to the same SCSI bus because they both use low voltage differential (LVD) signaling.

Fault Management Features

The array controller and the network operating system support several fault management and data reliability features that minimize the impact of hard drive defects on your system.

- **Auto-Reliability Monitoring** (ARM) is a background process that scans hard drives for bad sectors in fault-tolerant logical drives. ARM also verifies the consistency of parity data in logical drives that are using RAID 5 or RAID ADG. This process assures that you can recover all data successfully if a drive failure occurs in the future. ARM operates only when you select a fault-tolerant configuration (RAID 1 or higher).
- **Dynamic sector repair** by the controller automatically remaps any sectors that have media faults (detected either during normal operation or by auto reliability monitoring).
- **S.M.A.R.T.** is an industry-standard diagnostic and failure-prediction feature of hard drives, developed by Compaq in collaboration with the hard drive industry. It monitors several factors that can be used to predict imminent hard drive failure due to mechanical causes. Such factors include the condition of the read/write head, the seek error rate, and the spin-up time. When a threshold value is exceeded for one of these factors, the drive sends an alert that failure is imminent. Thus, the user can back up data and replace the drive before drive failure occurs.

  NOTE: An online spare does not become active and start rebuilding when the imminent failure alert is sent, because the degraded drive has not actually failed yet and is still online. The online spare is activated only after a drive in the array has failed.

- **Drive failure alert features** cause an alert message to be displayed on the system monitor when drive failure occurs. Different Compaq server models use different messages for different situations. These messages are described in your server documentation.
- **Interim data recovery** occurs if a drive fails in fault-tolerant configurations (RAID 1 or higher). In this situation, the system will still process I/O requests, but at a reduced performance level. Replace the failed drive as soon as possible to restore performance and full fault tolerance for that logical drive. Otherwise, if another hard drive fails before data has been rebuilt, the logical volume will fail and data will be lost. Refer to Appendix E for more information about recovering from drive failure.
- **POST** or the **Array Diagnostics Utility** will also reveal imminent drive failure.

- **Recovery ROM** is a redundancy feature that ensures continuous system availability by providing a backup ROM. This feature protects against corruption of a ROM image (caused, for example, by power fluctuation during ROM upgrade). If corruption occurs, the server automatically restarts using the remaining good copy of the ROM image.

  When you upgrade the ROM, the inactive image (the one not being used by the system) is upgraded. There is not normally any noticeable difference in operation. When you use Recovery ROM for the first time, however, both ROM images are upgraded, causing a boot delay of about 60 seconds.

Other Compaq options, such as Compaq Insight Manager, provide additional drive failure features. Refer to your authorized Compaq reseller for more information about these products.

2

Installation Overview

The details of the steps required to install the controller depend on whether the server has an operating system installed and contains data. The flowcharts in Figure 2-1 and Figure 2-2 summarize the installation procedures for the most common scenarios.

Procedure for a New System

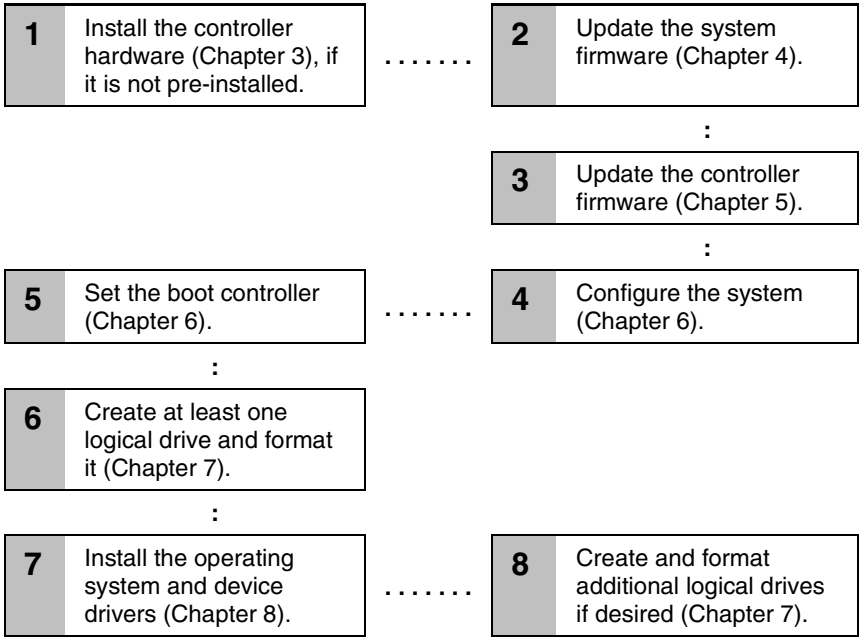


Figure 2-1: Controller installation in a new system

Procedure for a Pre-configured System

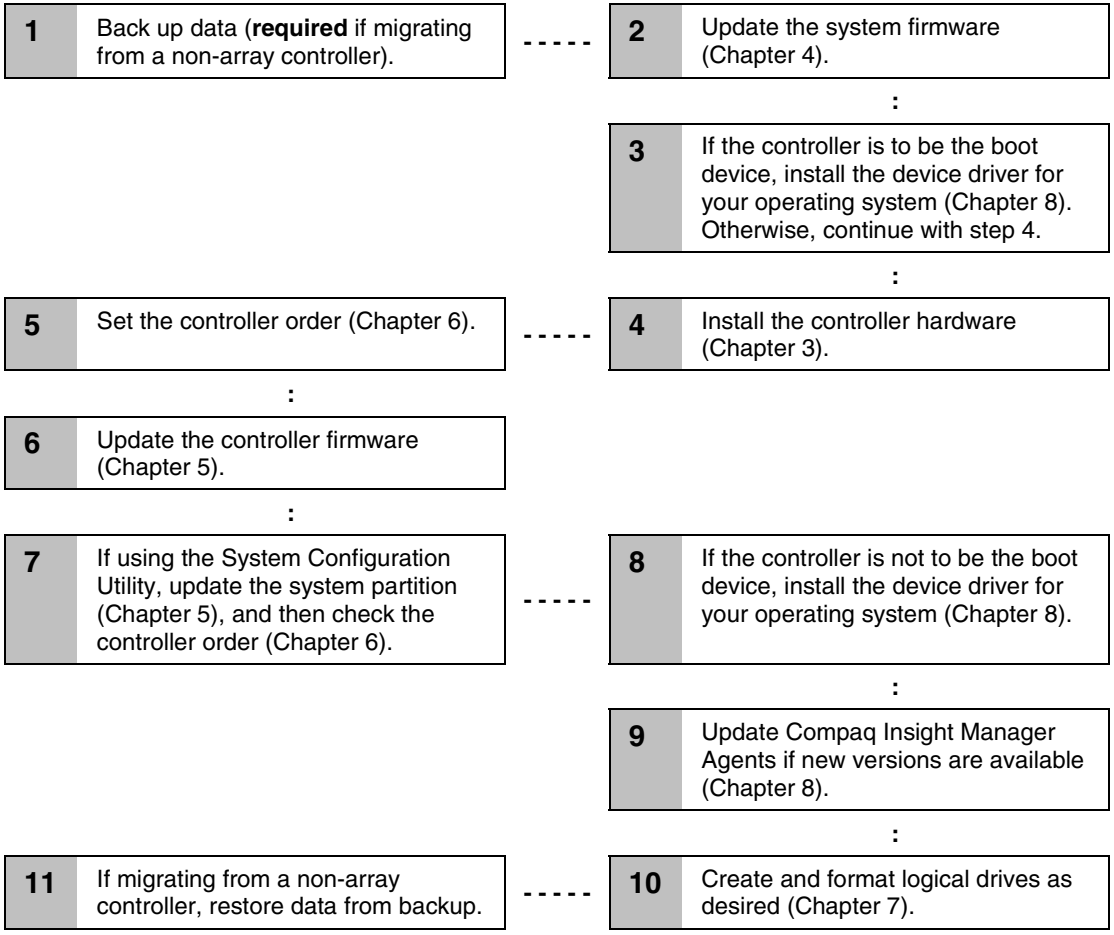


Figure 2-2: Controller installation in an already configured system

3

Installing the Hardware

Preparing the Server

Before installing the controller in the server, back up all data. This step is **mandatory** if you are moving non-arrayed SCSI drives to a Smart Array controller, because data is not preserved during a move between array controllers and non-array controllers.

WARNING: To reduce the risk of personal injury or damage to the equipment, consult the safety information and user documentation provided with your computer before attempting the installation.

Many computers are capable of producing energy levels that are considered hazardous. These computers are intended to be serviced by qualified personnel trained to deal with those hazards. Do not remove enclosures or attempt to bypass any interlocks that may be provided for the purpose of removing these hazardous conditions.

If your server supports hot-pluggable devices, go directly to the section, "Installing the Smart Array Controller."

To prepare a server that does not support hot-pluggable devices:

1. Close all applications.
2. Power down the server.

CAUTION: In systems using external data storage, be sure that the server is the first unit powered down and the last unit to be powered back up. Doing this ensures that the system will not erroneously mark the drives as "failed."

3. Power down any peripheral devices that are attached to the server.

4. Unplug the AC power cord from the outlet, and then from the server.

IMPORTANT: If you will be replacing a Smart controller with a Smart Array controller, see the "External Cabling for Compaq Servers" section to determine the external cabling requirements.

5. Disconnect any peripheral devices from the server.

WARNING: To reduce the risk of personal injury from hot surfaces, allow the internal system components and hot-plug hard drives to cool before touching them.

CAUTION: Electrostatic discharge (ESD) can damage electronic components. Be sure that you are properly grounded before continuing the installation procedure. See Appendix B for ESD information.

Installing the Smart Array Controller

1. Remove or open the access panel.
2. Select an available 66-MHz PCI slot. Slots that use a 64-bit interface may provide higher performance.
3. Remove the slot cover or open the hot-plug latch. Save the retaining screw, if one is present.
4. Slide the controller board along the slot alignment guide.

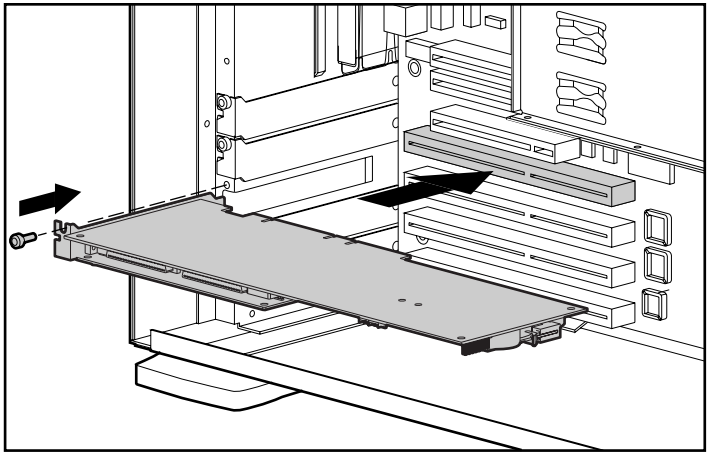


Figure 3-1: Installing a Smart Array 5300 Controller

NOTE: Your server may look slightly different from the one illustrated.

5. Press the controller board firmly into the slot so that the contacts on the board edge are properly seated in the system board connector.
6. Secure the board in place with the hot-plug latch or retaining screw.
7. Continue by following the instructions given in "Connecting the Cables."

Connecting the Cables

Each port on the controller supports up to 14 drives. Ports 1 and 2 each have two SCSI connectors, one for external storage units and one for internal hard drives in the server. The two connectors for a given port cannot be used simultaneously. Ports 3 and 4 (present on the 5304 model, and also on the 5302 model with an attached 2- to 4-channel adapter) are only for external storage units.

Peripherals attached to any of the connectors must have a unique SCSI ID value in the range of 0 to 15 (except ID 7, which is reserved for controller use). The SCSI ID value determines the priority given to the device when it attempts to use the SCSI bus.

On Compaq products that support hot-pluggable drives, the SCSI IDs for peripherals are automatically set. For non-hot-pluggable devices, the IDs must be set manually by using switches or jumpers on the device itself.

IMPORTANT: When replacing an existing Smart controller with a Smart Array controller without reconfiguring the arrays, all of the drives should be connected exactly as they were on the old controller (port 1 to port 1, controller 1 to controller 1, and so on).

SCSI buses require termination on both ends to prevent signal degradation. In Compaq servers and storage systems, however, the controller, SCSI cable, and backplane already provide this termination.

Internal Cabling for Compaq Servers

1. If the device is not hot pluggable, power down the system.
2. Install drives into the removable media bays on the server. Drives that are to be grouped in the same array should have the same capacity.

   For detailed drive installation instructions, consult the documentation that accompanied your drives.

   The exact procedure from this point depends upon whether the device is hot pluggable.

   — If the drives are hot pluggable, go to step 3.

   — If the drives are not hot pluggable, go to step 4.
3. Attach the internal point-to-point SCSI cable (provided with your server) from an internal port of the controller to the hot-plug drive cage.

   For duplex drive cage options, use both internal ports.

   The hot-pluggable drives are now ready to use.
4. For each SCSI bus, manually set the SCSI ID on each drive to a unique value in the range of 0 to 15, except 7 (which is reserved for controller use). For detailed instructions, consult the documentation that is provided with the drive.
5. Attach the multi-device SCSI cable from the internal port 1 or port 2 of the Smart Array controller to the non-hot-pluggable hard drives.

The multi-device cable may have been provided with your server. If you need additional cables, order the cable option kit, Part Number 166389-B21. This cable is equipped to terminate either Wide Ultra3 or Wide Ultra2 drives.

CAUTION: Cable assembly 148785-001 is included in option kit 166389-B21 and is **required** with Wide Ultra3 drives. Failure to use this cable may result in reduced performance and/or data loss.

For additional information about drive installation, see Appendix E.

External Cabling for Compaq Servers

All Compaq Storage Enclosure models include external SCSI cables. Check the connector type on your storage device to identify the cable type needed. See Figure 3-2 and Table 3-1 for details.

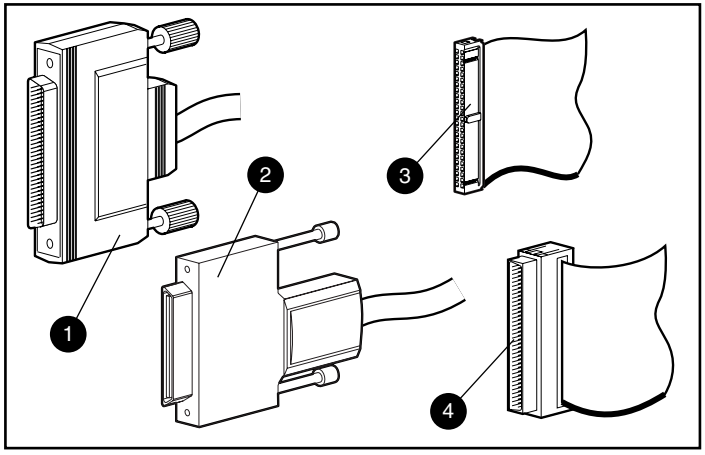


Figure 3-2: Identifying SCSI cable connectors

Item	Description
1	External 68-pin Wide
2	External offset VHDCI
3	Internal 50-pin narrow
4	Internal 68-pin Wide

Table 3-1: External SCSI Cables for Compaq Enclosures

Cable Type	Length	Option Kit Number	Cable Assembly Number
VHDCI to VHDCI	1.8 m / 6 ft	341174-B21	313374-001
VHDCI to VHDCI	3.6 m / 12 ft	341175-B21	313374-002
VHDCI to VHDCI	7.2 m / 24 ft	164604-B21	313374-004
VHDCI to VHDCI	11.7 m / 39 ft	150214-B21	313374-005
VHDCI to Wide	1.8 m / 6 ft	341176-B21	313375-001
VHDCI to Wide	3.6 m / 12 ft	341177-B21	313375-002

Note: If additional cables are required, order by the option kit number.

Up to four SCSI ports may be available for connection to external storage devices depending on whether the 2- to 4-channel adapter is attached and whether internal drives are connected to the array controller.

1. On the rear of the server, connect the cable to the VHDCI connector on the Smart Array controller, and then tighten the lock screws on the cable connector.

   IMPORTANT: Offset VHDCI cables **must** be used with the Smart Array 5300 controller. Early versions of the VHDCI cables do not accommodate side-by-side connection of the cables to the Smart Array 5300 controller. If your storage enclosure did not include the Offset VHDCI cables, you may need to order these. See Table 4-1 for Compaq part numbers.

   NOTE: Do not use a port externally if it is already being used internally.

2. Attach the other end of the cable to the Compaq storage enclosure, and then tighten the lock screws on the cable connector.
3. Replace the access panel and secure it with the thumbscrews, as required.

CAUTION: Do not operate the server with the access panel removed for extended periods of time. This precaution is to protect thermally sensitive components by ensuring the proper airflow through the server, and also to minimize personal contact with hazardous energy levels.

4

Updating the System Firmware

To update the system firmware, the Compaq System *ROMPaq*™ utility is used.

NOTE: This utility is not to be confused with the Options ROMPaq utility (refer to Chapter 5), which is used to update the firmware on server options and SCSI drives.

This utility has two main sources:

- The Compaq *SmartStart*™ CD that is either shipped with your server or available directly from Compaq
- The downloadable Compaq *SoftPaq*™ file on the Compaq website

If your server has a bootable CD-ROM drive, you can run System ROMPaq directly from the CD. Otherwise, you must run System ROMPaq from a diskette created from either the CD or from the SoftPaq file.

IMPORTANT: Compare the version numbers of the System ROMPaq utility from these two sources. If the CD version is older, use the SoftPaq file instead.

Running System ROMPaq from the CD

1. Boot the server from the SmartStart CD.
2. On the **Compaq System Utilities** screen, select **Run ROMPaq.**
3. Follow the on-screen prompts and instructions to reprogram your system ROM.

Running System ROMPaq from Diskette

To run System ROMPaq from diskette, you must first create a System ROMPaq diskette from the CD or from the appropriate SoftPaq file.

Creating a System ROMPaq Diskette from the CD

1. Insert the SmartStart CD into the CD-ROM drive tray of a server with a bootable CD-ROM drive.
2. Restart the server.
3. On the **Compaq System Utilities** screen, select **Create Support Software.**
4. On the **Diskette Builder** screen, scroll through the list and select **System ROMPaq Firmware Upgrade Diskette,** and then click **Next.**
5. Select **Create Diskettes Only,** and then click **Next.**
6. Follow the remaining instructions on the screen to create the System ROMPaq diskette.
7. To update the firmware, follow the procedure given in "Using the Diskette."

Creating a System ROMPaq Diskette from the SoftPaq File

1. Create a temporary directory on your hard drive.
2. Go to www.compaq.com and locate the page containing the SoftPaq file for the System ROMPaq utility.
3. Click the link for the System ROMPaq SoftPaq file.
4. Click **Download,** and direct the download to the temporary directory that you created.
5. Click **Save.**
6. Execute the downloaded SoftPaq file and follow the on-screen instructions to create the System ROMPaq diskette.
7. To update the firmware, follow the procedure given in "Using the Diskette."

Using the Diskette

1. With the server powered down, place the System ROMPaq diskette in the diskette drive.
2. Power up the server.
3. When the **Welcome** screen is displayed, press the **Enter** key.
4. When the **Select A Device** screen is displayed, select your server from the list of programmable devices, and then press the **Enter** key.

   The **Select An Image** screen is displayed, showing the following information:

   ```
   Device to reprogram:          your server
   Current ROM revision:         date of existing ROM version
   Select Firmware Images:       date of latest ROM version
   ```

5. Press the **Enter** key. The **Caution** screen is displayed.
6. Press the **Enter** key. The following message is displayed:

   ```
   Reprogramming Firmware
   ```

   Do not interrupt the reprogramming process. You will be notified when reprogramming is complete.
7. When reprogramming has finished, press the **Esc** key to exit the utility.
8. Remove the System ROMPaq diskette and restart the server.

5

Updating the Controller Firmware

You can update the firmware on Compaq options by using the Options ROMPaq utility. There are two versions of this utility: Options ROMPaq for Array Controllers, and Options ROMPaq for Internal (SCSI Attached) Drives.

If you purchased your server with an array controller already installed, you do not need to run this utility during server installation. However, if you have older Smart Array Controllers or other Compaq options (such as drives), run Options ROMPaq to make sure that these devices have the latest firmware. Compaq recommends that you run the latest Options ROMPaq on all Compaq array controllers whenever new versions of the utility are released.

The Options ROMPaq utility has three main sources:

- The SmartStart CD
- The Smart Array Controller Support Software CD
- The downloadable SoftPaq file on the Compaq website

If your server has a bootable CD-ROM drive, you can run Options ROMPaq directly from the CD. Otherwise, you must run Options ROMPaq from a diskette created from the CD or from the SoftPaq file.

IMPORTANT: Compare the version numbers of the Options ROMPaq utility from these sources. If the CD version is older, use the SoftPaq file instead.

If your system uses the System Configuration Utility (SCU), you might also need to update the system partition to complete the system update.

Running Options ROMPaq from the CD

1. Place the CD in the server CD-ROM drive.
2. Restart the server.
3. When the **System Utilities Menu** screen is displayed, select **Run Options ROMPaq,** and then press the **Enter** key.
4. When the **Welcome** screen is displayed, press the **Enter** key.
5. On the **Select A Device** screen, select **All Compaq Smart Array 5300 Controller(s)** from the list of programmable devices, and then press the **Enter** key.
6. The action that you must now take depends on the message on the screen.
   - — If the screen message reads as follows, press the **Enter** key, and then go to step 8 of these instructions:

     ```
     The ROM image files found for the device selected are not
     newer than the current ROM image
     ```

   - — If the ROM firmware currently on the controller is older than that on the Options ROMPaq diskette, then the screen message reads as follows:

     ```
     Device to reprogram:    All Compaq Smart Array 5300
     Controller(s)
     Controller(s) Current ROM revision: Compaq Smart Array
     5300 Controller x.xx
     Select Firmware Images: Compaq Smart Array 5300
     Controller y.yy
     ```

     In this case, press the **Enter** key and then go to step 7.
7. Review the information on the **Caution** screen, and then press the **Enter** key to reprogram the controller ROM.

   The following message is displayed:

   ```
   Reprogramming Firmware
   ```

   Do not interrupt the reprogramming process. You will be notified when reprogramming is complete.

8. When reprogramming of the controller ROM is finished, you can reprogram more options or exit the utility.
   - — To reprogram another Compaq option, press the **Enter** key, and then repeat steps 5 through 7.
   - — If you have finished reprogramming Compaq options, press the **Esc** key to exit the utility.
9. Remove the CD and restart the server.

Running Options ROMPaq from Diskettes

To run Options ROMPaq from diskettes, first create Options ROMPaq diskettes from one of the CDs or from the appropriate SoftPaq file.

Creating Diskettes Using the Smart Array Controller Support Software CD

1. Insert the Smart Array Controller Support Software CD into the server CD-ROM drive tray.
2. Open the **OPTRMDSK** folder on the CD and execute the QRST5.EXE file.
3. Follow the on-screen prompts to create the set of Options ROMPaq diskettes.
4. To complete the firmware update, follow the procedure given in the section, "Using the Diskettes."

Creating Diskettes Using the SmartStart CD

1. Insert the SmartStart CD into the CD-ROM drive tray of a server with a bootable CD-ROM drive.
2. Restart the server.
3. On the **Compaq System Utilities** screen, select **Create Support Software.**
4. On the **Diskette Builder** screen, scroll through the list and select **Options ROMPaq,** and then click **Next.**

5. Choose **Create Diskettes Only** and then click **Next.**
6. Follow the remaining on-screen instructions to create the Options ROMPaq diskettes.
7. To complete the firmware update, follow the procedure given in the section, "Using the Diskettes."

Creating Diskettes Using the SoftPaq File

1. Create a temporary directory on your hard drive.
2. On the Compaq website, locate the page containing the SoftPaq file for the Options ROMPaq utility.
3. Click the link for the Options ROMPaq SoftPaq file.
4. Click **Download,** and direct the download to the temporary directory that you created.
5. Click **Save.**
6. Execute the downloaded SoftPaq file and follow the on-screen instructions to create the diskette. Up to six diskettes are needed for the Options ROMPaq SoftPaq file.
7. To complete the firmware update, follow the procedure given in the section, "Using the Diskettes."

Using the Diskettes

1. Confirm that the server is off.
2. Insert the first Options ROMPaq diskette into the diskette drive.
3. Restart the server.
4. When the **Welcome** screen is displayed, press the **Enter** key.

   The **Select a Device** screen is displayed.

5. If the controller that you want to update the firmware for is on the list of programmable devices, select it and press the **Enter** key. (If it is not present, you are prompted to insert the remaining diskettes for devices not listed on the first diskette.)
6. The action that you must now take depends on the message on the screen.
   - If the screen message reads as follows, press the **Enter** key, and then go to step 8 of these instructions:

     ```
     The ROM image files found for the device selected are not
     newer than the current ROM image
     ```

   - If the ROM firmware currently on the controller is older than that on the Options ROMPaq diskette, then the screen message reads as follows:

     ```
     Device to reprogram:    All Compaq Smart Array nnnn
     Controller(s)
     Controller(s) Current ROM revision: Compaq Smart Array
     nnnn Controller x.xx
     Select Firmware Images: Compaq Smart Array nnnn
     Controller y.yy
     ```

     In this case, press the **Enter** key and then go to step 7.
7. Review the information on the **Caution** screen, and then press the **Enter** key to reprogram the controller ROM.

   The following message is displayed:

   ```
   Reprogramming Firmware
   ```

   Do not interrupt the reprogramming process. You will be notified when reprogramming is complete.
8. When the reprogramming of the array controller ROM is finished, you can reprogram more options or exit the utility.
   - To reprogram another Compaq option, press the **Enter** key, and then repeat steps 5 through 7.
   - If you have finished reprogramming Compaq options, press the **Esc** key to exit the utility.
9. Remove the Options ROMPaq diskette and restart the server.

Updating the System Partition

If you are installing the controller on a server that was previously configured with SCU, you must now use this utility to update the system partition.

NOTE: If your server uses the ROM-Based Setup Utility (RBSU), you do not need to run SCU.

SCU is provided on both the SmartStart CD and the Smart Array Controller Support Software CD. Compare the SCU version numbers from these two sources and use the most recent version.

NOTE: Before updating Novell NetWare volumes or partitions, remember these tips to optimize system performance:

- If you want to use hardware-based RAID, do not select mirroring while using INSTALL.NLM or NWCONFIG.NLM.
- Novell recommends that you create volumes with a 64-kbyte block size to decrease the amount of RAM required to mount the volume, and use the Block Sub-Allocation feature to allow disk space to be allocated more efficiently.
- Linear memory provides the best system performance in the NetWare environment. If you previously used SCU to configure your server, this option would have been the default. To check that the system is using linear memory, run SCU and view the Compaq Memory settings. Confirm that a linear option is selected under the Base Memory option.

1. Restart the server from the CD.
2. If the CD-ROM drive is bootable, go to step 5. Otherwise, locate the *CD-ROM drive*:\SYSCFDSK\US directory, run the file QRST5.EXE, and follow the on-screen instructions to create four SCU diskettes.
3. Insert SCU diskette #1 into the server diskette drive.
4. Restart the system.
5. Select **System Configuration Utility** from the menu or list of icons that is displayed.
6. Follow the on-screen instructions to update or create and populate a system partition.
7. Exit from SCU. If the server does not reboot or a CD error message is displayed, press the **Ctrl+Alt+Del** keys to continue and reboot the server.

6

Setting the Controller Order

After installing the controller hardware and updating the controller firmware:

- Configure the system by using either the ROM-Based Setup Utility (RBSU) or the System Configuration Utility (SCU), following the procedure given in the server user guide.
- Set the boot controller by using RBSU or the Option ROM Configuration for Arrays (ORCA) utility (described in this chapter).
- Create at least one logical drive by using ORCA or ACU (as described in Chapter 7).

Using RBSU

RBSU is a system configuration utility that is embedded in the system ROM, and is customized for the server that it is installed on. Update RBSU when necessary by using System ROMPaq.

CAUTION: Not all servers support RBSU. Do not flash an RBSU-ROM image onto a server that is already configured with SCU unless the update instructions specifically state that upgrading from SCU to RBSU is supported. If the upgrade is not supported, the consequences of upgrading are unpredictable and you may lose data.

To use RBSU:

1. Power up the server.
2. Press the **F9** key when prompted during system startup.

   The main ROM-Based Setup Utility screen is displayed.

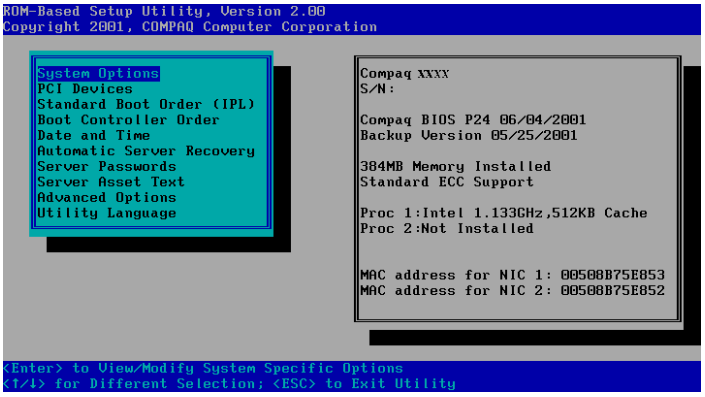


Figure 6-1: Main ROM-Based Setup Utility screen

3. Configure your system. (For detailed instructions, refer to the *Compaq ROM-Based Setup Utility User Guide.*)
4. Select **Boot Controller Order** on the main RBSU screen and follow the on-screen prompts to set the boot controller.
5. When you have finished using the utility, press the **Esc** key, and then press the **F10** key to confirm that you want to exit RBSU.

Using ORCA

Part of the startup sequence of a server is the Power-On Self-Test (POST). If the array controller in the server supports ORCA, POST temporarily halts and an ORCA prompt message is displayed for about five seconds. (If ORCA is not supported, the prompt message is not displayed and the system continues with the startup sequence.)

1. Power up the server and let the system startup sequence begin.
2. While the prompt message is on the screen, press the **F8** key to start ORCA.

3. On the **Option ROM Configuration for Arrays Main Menu** screen, select **Select as Boot Controller** and follow the prompts to set the boot controller for the system.

If you want to use ORCA to create logical drives at this point, you do not need to exit the utility yet. Continue using ORCA as described in Chapter 7.

7

Configuring an Array

Compaq provides four utilities for configuring an array:

- **Option ROM Configuration for Arrays (ORCA)**—a simple ROM-based configuration utility that runs on all operating systems
- **Array Configuration Utility (ACU)**—a versatile configuration utility that provides maximum control over configuration parameters
- **Array Configuration Utility XE (ACU-XE)**—a browser-based version of ACU
- **NetWare Online Array Configuration Utility (CPQONLIN)**—a menu-driven utility for NetWare

The following limitations apply to all configuration methods:

- For the most efficient use of drive space, do not mix drives of different capacity within the same array. Each configuration utility treats all physical drives in an array as if they have the same capacity as the smallest drive in the array. Excess capacity of larger drives is wasted because it is unavailable for data storage.
- The probability that an array will experience a hard drive failure increases with the number of hard drives in the array (for more detailed information, refer to Appendix F). If you configure an array with RAID 5, keep the probability of failure acceptably low by using no more than 14 drives.

This chapter describes how to use ORCA, ACU, and CPQONLIN. For detailed information about using ACU-XE, refer to the *Compaq Array Configuration Utility XE User Guide.* For background information about drive arrays and fault-tolerance (RAID) methods, refer to Appendix D.

Table 7-1: Comparison of Utilities for Configuring an Array

	ACU	ACU-XE	CPQONLIN	ORCA
Uses a graphical interface	+	+	0	0
Available in languages other than English	+	+	0	0
Executable at any time	+	+	+	0
Available on CD	+	+	+	0
Uses a wizard to suggest the optimum configuration for an unconfigured controller	+	+	+	0
Describes configuration errors	+	+	0	0
Supports these operating systems:				
Windows 2000	+	+	0	+
Windows NT	+	+	0	+
NetWare	+*	+*	+	+
Linux	+*	+	0	+
Allows these procedures:				
Creation and deletion of arrays, logical drives	+	+	+	+
Assignment of RAID level	+	+	+	+
Sharing of spare drive among several arrays	+	+	+	0
Assignment of multiple spare drives per array	+	+	+	0
Setting of stripe size	+	+	+	0
Migration of RAID level or stripe size	+	+	+	0
Configuration of controller settings	+	+	+	0
Expansion of an array	+	+	+	0
Creation of multiple logical drives per array	+	+	+	+
Setting of boot controller	0	0	0	+

*An array can be configured in these cases only when the system is offline.

Using ORCA

When a computer system is powered up, part of the startup sequence is the Power-On Self-Test (POST). Any array controllers that are in the system are initialized while POST is running. If the array controller supports ORCA, POST temporarily halts and an ORCA prompt message is displayed for about five seconds. (If ORCA is not supported, the prompt message is not displayed and the system continues with the startup sequence.)

While the prompt is displayed, press the **F8** key to start ORCA. The ORCA main menu is displayed, allowing you to select the boot controller for the system, or to create, view, or delete a logical drive.

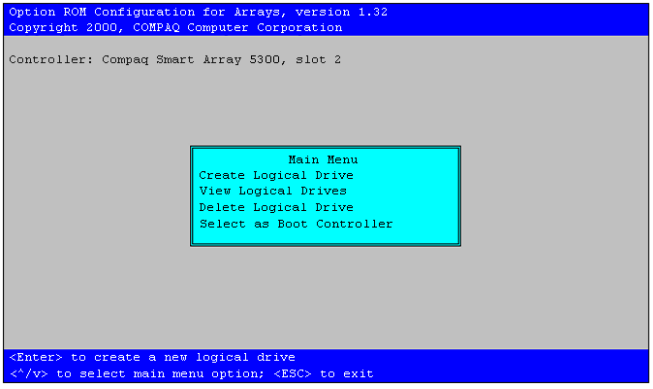


Figure 7-1: ORCA main menu screen

To create a logical drive:

1. Select **Create Logical Drive.**

   The screen displays a list of all available (unconfigured) physical drives and the valid RAID options for your system.

   NOTE: You can create only one logical drive at a time.

2. Use the arrow keys, space bar, and tab key to navigate around the screen and set up your logical drive, including a spare drive if required.

NOTE: ORCA allows only one array to use a given online spare.

3. Press the **Enter** key to accept the settings.
4. Press the **F8** key to confirm your settings and save the new configuration.

   After several seconds, the **Configuration Saved** screen is displayed.
5. Press the **Enter** key to continue.

You can now create another logical drive by repeating the previous steps.

NOTE: Raw logical drives are invisible to the operating system. To make the new logical drives available for data storage, format the logical drive using the instructions given in your operating system documentation.

Using ACU

The Array Configuration Utility is located on the Smart Array Controller Support Software CD and on the SmartStart CD. You can run ACU directly from one of these CDs, or—if the server you are configuring is running the Microsoft Windows NT or Windows 2000 operating system—you can download ACU onto your server and run it online.

When you start ACU, it checks the configuration of every controller and drive array. If an array is not configured optimally, the ACU configuration wizard opens and guides you through the configuration process. The wizard also helps you to configure any new controllers, assign unused physical drives to existing arrays (without destroying data), and configure any unused space present on an array into another logical drive. ACU allows you to create up to 32 logical drives per array.

If a problem arises during the configuration process, ACU displays an error message describing the problem. If the following warning message is displayed along with an error code number, call your local Compaq technical support number for assistance:

```
Internal Error Has Occurred
```

For technical support phone numbers, refer to the “About This Guide” section.

You can view context-sensitive online help for each screen by pressing the **F1** key or clicking **Help.** The status bar at the bottom of the screen also displays messages that describe the current selection.

NOTE: Raw logical drives are invisible to the operating system. To make the new logical drives available for data storage, format the logical drive using the instructions given in your operating system documentation.

Running ACU from CD

This method of running ACU is valid for Windows NT, Windows 2000, Linux, and Novell NetWare operating systems.

1. Insert the CD into the CD-ROM drive and restart the server.
2. When the CD menu is displayed, double-click the **ACU** icon.
3. Configure your array (if you do not want to use the wizard, refer to the "Typical Manual Configuration Procedures in ACU" section for detailed procedures).
4. Remove the CD and restart the server to activate the new settings.

Running ACU while Online

You can run ACU online with Windows NT or Windows 2000 operating systems.

1. Insert the CD into the CD-ROM drive of the server and follow the on-screen instructions to download the utility.
2. When installation is complete, click **Start** and select **Compaq System Tools.**
3. Double-click the **ACU** icon.

ACU Screen Descriptions

NOTE: The screenshots shown with these descriptions are merely examples. The exact appearance of your screen depends on the controller and hard drives that you use. For example, the number of ports on the controller and the RAID levels available may be different in your case.

Main ACU Screen

After the configuration wizard has finished or been bypassed, the screen looks like Figure 7-2. This is the main ACU screen.

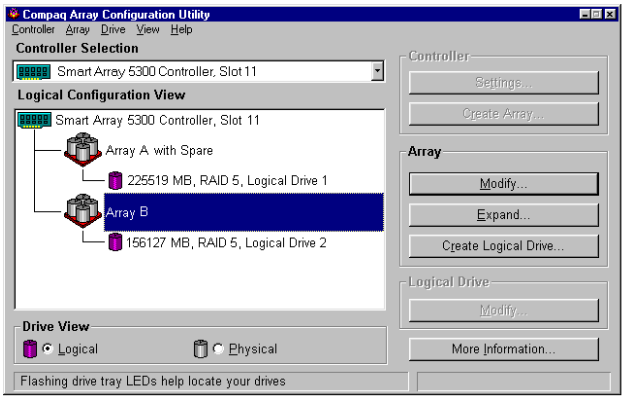


Figure 7-2: Main ACU screen

This screen contains the following regions:

- Menu bar
- **Controller Selection** drop-down list
- **Configuration View** window
- **Drive View** box
- **Controller** box
- **Array** box
- **Logical Drive** box
- **More Information** button

Some buttons will be grayed out. You cannot select grayed-out buttons until you select an item in the configuration view window that provides that option.

Menu Bar

The menu bar at the top of the main ACU screen contains the following drop-down menus:

- **Controller**—Allows you to select a controller, refresh the screen, save or clear a configuration, create an array, or exit the program. Other menu items give access to settings, advanced features, information, and the configuration wizard.
- **Array**—Allows you to delete or modify an array, or to expand array capacity, create logical drives, and view array information.
- **Drive**—Allows you to delete or change logical drives and to view drive information.
- **View**—Allows you to switch between **Physical Configuration View** and **Logical Configuration View.**
- **Help**—Allows you to access online help.

Controller Selection Drop-Down List

This lists the controllers that are installed in the system. When you select a controller, details of the drives and arrays that are connected to the controller are shown in the configuration view window.

Figure 7-3: Controller Selection drop-down list

Physical/Logical Configuration View Window

The physical/logical configuration view window shows the drives and arrays that are connected to the selected controller. The **Drive View** radio buttons below the configuration view window let you switch between the physical and logical configuration views.

Figure 7-4 shows a typical physical configuration view, while Figure 7-2 shows a typical logical configuration view.

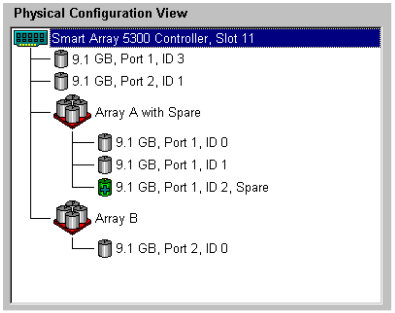


Figure 7-4: Physical Configuration View window

NOTE: Selecting any item in the configuration view window will cause the corresponding hard drive tray LEDs to blink. This feature is useful for identifying all physical drives in an array or logical drive, all drives on a controller, or a specific physical drive.

Drive View Box

Select the radio buttons in this box to display a logical or physical configuration view in the configuration view window.

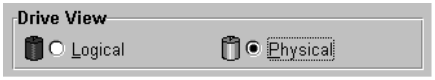


Figure 7-5: Drive View box

Controller Box

The buttons in the **Controller** box are activated when you select a controller in the **Controller Selection drop-down list.**

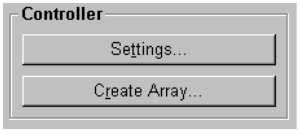


Figure 7-6: Controller box

Click one of these buttons to display the **Controller Settings** screen or the **Create Drive Array** screen.

Array Box

The buttons in the **Array** box are activated when you select an array in the configuration view window.

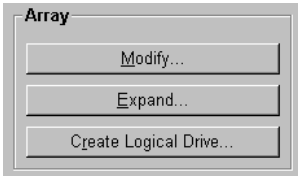


Figure 7-7: Array box

Click one of these buttons to display the **Modify Drive Array** screen, the **Expand Array** screen, or the **Create Logical Drive** screen.

Logical Drive Box

The buttons in the **Logical Drive** box are activated when you select a logical drive in the configuration view window.

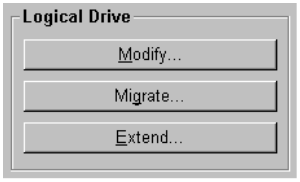


Figure 7-8: Logical Drive box

Click one of these buttons to display the **Modify Logical Drive** screen, the **Migrate Logical Drive** screen, or the **Extend Logical Drive** screen.

More Information Button

Click **More Information** (located in the bottom right corner of the main ACU screen) to get a detailed description of the item that is selected in the configuration view window.

Secondary Screens

Controller Settings Screen

To display this screen, click **Settings** in the **Controller** box (Figure 7-6) on the main ACU screen.

This screen allows you to set the rebuild priority, expand priority, and accelerator read/write ratio.

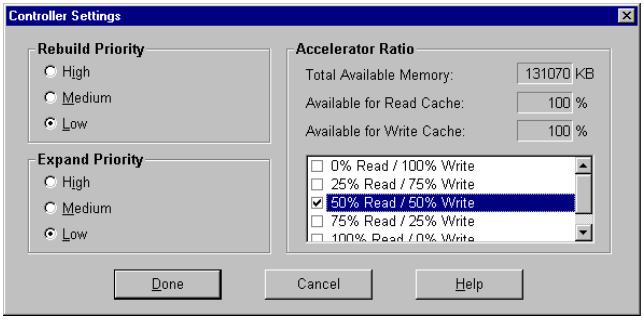


Figure 7-9: Controller Settings screen

The settings that you select for **Rebuild Priority** and **Expand Priority** will not affect the performance of an idle system. However, they will affect performance on a busy system:

- On the **High** settings, the controller will give preference to the rebuild or expansion process over normal I/O operations.
- On the **Low** settings, the controller will rebuild or expand only when the controller is idle. However, this setting leaves the array vulnerable to drive failure for a longer time than the **High** setting.

The **Accelerator Ratio** settings determine the amount of memory allocated to the read and write caches. Some applications may perform better with a larger write cache; others may perform better with a larger read cache. If your controller does not have a battery-backed array accelerator, only read cache will be available (the ratio will always be 100% Read / 0% Write).

NOTE: If you optimize the **Accelerator Ratio** settings, you may also want to change the **Stripe Size** setting. For details, refer to the "Create Logical Drive Screen" section, Table 7-2, and Table 7-3.

Create Drive Array Screen

To display this screen, click **Create Array** in the **Controller** box (Figure 7-6) on the main ACU screen.

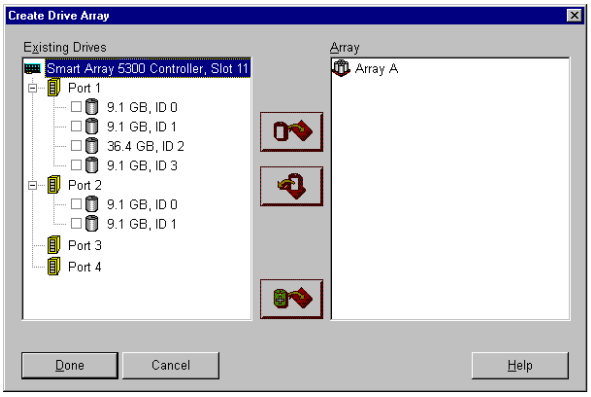


Figure 7-10: Create Drive Array screen

The three buttons in the middle of this screen, from top to bottom, are:

- **Assign Drive to Array**
- **Remove Drive from Array**
- **Assign Spare to Array**

The left-hand panel of the screen shows all the physical drives that are connected to the selected controller. The right-hand panel shows the physical configuration view of the arrays on the controller.

When you select a drive in one of the panels, the appropriate buttons become functional. You can select several drives at a time from the same panel, and assign or remove them all simultaneously; in this case, the buttons each show two drives. Also, if spare drives are selected in the right-hand panel, the design on the middle button changes to denote the removal of spare drives.

Modify Drive Array Screen

To display this screen, click **Modify** in the **Array** box on the main ACU screen. This screen resembles the **Create Drive Array** screen (Figure 7-10), and it allows you to change the configuration of your array.

Expand Array Screen

To display this screen, click **Expand** in the **Array** box on the main ACU screen.

The **Expand Array** screen resembles the **Create Drive Array** screen (Figure 7-10). It allows you to add more hard drives to an array that has already been configured. The extra capacity can be used to build another logical drive on the array, or to extend a logical drive that already exists on the array.

Create Logical Drive Screen

To display this screen, click **Create Logical Drive** in the **Array** box (Figure 7-7) on the main ACU screen.

This screen allows you to select the fault-tolerance method, enable the array accelerator (if present), and set the stripe size and logical drive size on a new logical drive.

CAUTION: Do not use this screen to modify a pre-existing logical drive, since this method does **not** preserve user data. Instead, to change the RAID level and stripe size on a logical drive that **already contains user data**, click **Migrate** on the main ACU screen to reach the **Migrate RAID/Stripe Size** screen (Figure 7-13).

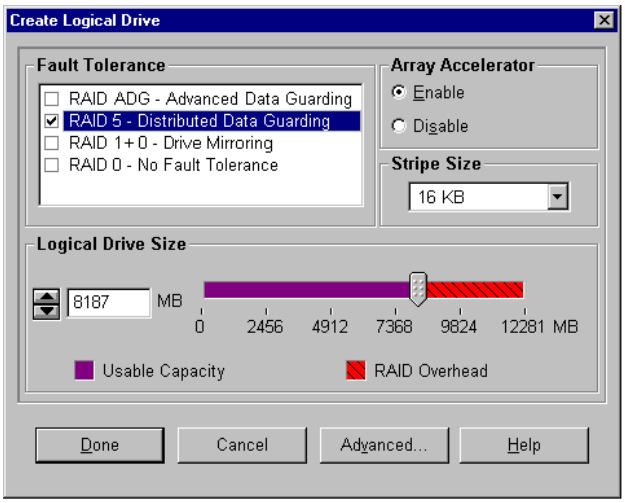


Figure 7-11: Create Logical Drive screen

Three features on this screen merit further description:

- **Stripe Size** box
- **Logical Drive Size** box
- **Advanced** button

The **Stripe Size** box has a drop-down list that lets you select the width of a data stripe. (This width corresponds to the size of a data block on each hard drive in the logical volume, as described in Appendix D).

Each RAID level supports several stripe widths (Table 7-2); the default stripe size initially displayed by ACU is chosen for optimum performance under the most common operating conditions. Table 7-3 suggests how to change the stripe width to optimize system performance for different types of application.

Table 7-2: Supported Stripe Sizes for a Given RAID Level

Fault Tolerance Level	Supported Stripe Sizes (KB)	Default (KB)
RAID 0, RAID 1+0	8, 16, 32, 64, 128, 256	128
RAID 5, RAID ADG	8, 16, 32, 64	16

Table 7-3: Optimum Stripe Size for a Given Application

Type of Server Application	Suggested Stripe Size Change
Mixed read/write	Accept the default value
Mainly sequential read (such as audio/video applications)	Use larger stripe sizes for best performance
Mainly write (such as image manipulation applications)	Use smaller stripes for RAID 5 Use larger stripes for RAID 0, RAID 1+0

The **Logical Drive Size** box shows how much drive capacity is available on the selected logical drive when using the chosen RAID level. The left side of the slider scale shows how much drive capacity is available for data storage, while the right side indicates how much capacity is required for storing parity or mirrored information. (RAID overhead is not needed for RAID 0.)

The default logical drive size first shown in this box is the maximum available for your drive array. To create more than one logical drive on the array, reduce the logical drive size by typing a smaller number in the scroll box. ACU allows you to create up to 32 logical drives per array.

Click **Advanced** to display the **Create Logical Drive – Advanced Features** screen, where you can enable or disable the maximum boot size for a logical drive. The default boot size is 32 sectors (16 kbytes) per track, and the maximum boot size is 63 sectors per track.

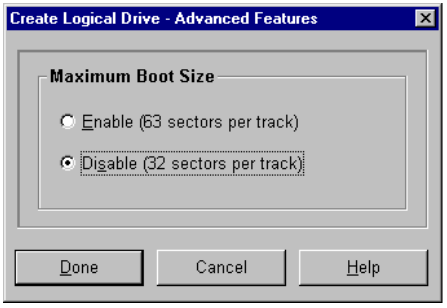


Figure 7-12: Create Logical Drive – Advanced Features screen

Some operating systems need to use the maximum boot size to be able to create large boot partitions. For example, enabling the maximum boot size on a logical drive in the Windows NT 4.0 operating system allows you to create a bootable partition with a maximum size of 8 GB.

NOTE: Enabling the maximum boot size may decrease performance of the logical drive.

Modify Logical Drive Screen

To display this screen, click **Modify** in the **Logical Drive** box (Figure 7-8) on the main ACU screen. This screen resembles the **Create Logical Drive** screen (Figure 7-11), and lets you change the parameters of an existing logical drive while online, without causing data loss.

Migrate RAID/Stripe Size Screen

To display this screen, click **Migrate** in the **Logical Drive** box (Figure 7-8) on the main ACU screen. It allows you to change the stripe width (block size) or RAID level of an existing logical drive while online, without causing data loss.

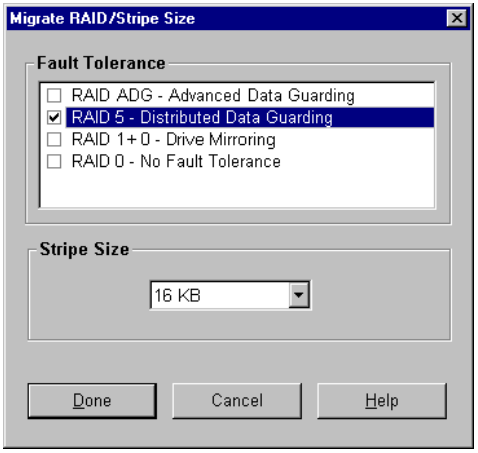


Figure 7-13: Migrate RAID/Stripe Size screen

Extend Logical Drive Screen

To display this screen, click **Extend** in the **Logical Drive** box (Figure 7-8) on the main ACU screen. This screen allows you to increase the capacity of a logical drive while the system is online, without disruption of data.

IMPORTANT: Not all operating systems support online capacity extension. For more information, refer to the section "Extending Logical Drive Capacity."

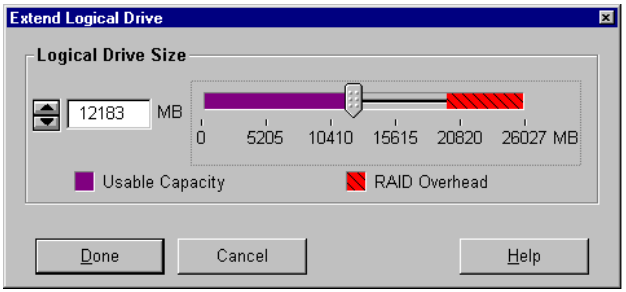


Figure 7-14: Extend Logical Drive screen

Typical Manual Configuration Procedures in ACU

When you launch ACU to configure a new array, a configuration wizard opens to allow rapid, automatic array configuration. However, you can bypass the wizard and manually:

- Create a new array.
- Expand the capacity of an array.
- Extend the capacity of a logical drive.
- Migrate to a different RAID level or stripe size.

Creating a New Array

There are three stages in the procedure for manually creating a new array:

1. Configure the controller settings.
2. Assign physical drives of the same size to an array.

3. Create one or more logical drives on the array.

For this example, assume that you have ten 9.1-GB drives connected to your controller. You want to make two arrays:

- Array A: seven 9.1-GB drives with a spare, configured with RAID 5 fault tolerance
- Array B: two 9.1-GB drives in a RAID 1+0 fault-tolerance configuration

Configuring the Controller Settings

1. On the main ACU screen, select the controller to be used from the drop-down list in the **Controller Selection** box. (Alternatively, click **Controller** on the menu bar, and then click **Select.**)
2. Click **Controller Settings.**

   The **Controller Settings** screen is displayed (Figure 7-9).
3. Select the rebuild priority, expand priority, and accelerator ratio.
4. Click **Done** to return to the main ACU screen.

Assigning Physical Drives of the Same Size to an Array

1. Click **Create Array** in the **Controller** box.

   The **Create Drive Array** screen is displayed (Figure 7-10).
2. Select the drives that are to constitute the array from the drive list in the left panel.

   — Do not assign a group of physical drives to the same array unless they are of the same capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and is wasted.

   — The probability that an array will experience a drive failure increases with the number of drives in the array. Compaq recommends that no more than 14 drives be used per array in RAID 5 configurations.

   For this example, select the seven drives on Port 1 with SCSI IDs 0 through 6.

3. Click the **Assign Drive to Array** button (Figure 7-15) in the middle of the screen.

Figure 7-15: Assign Drive to Array button

4. Select the drive at Port 1: SCSI ID 7 and click the **Assign Spare to Array** button in the lower middle part of the screen.

NOTE: You can share any given spare among several arrays. You can also assign several spares to just one array, or share one group of spares among several arrays. In all such cases, be sure that the capacity of each spare is large enough for each array that it is assigned to. (The capacity of a spare must be no less than that of any other drives in the same array.)

The **Create Drive Array** screen now looks like Figure 7-16.

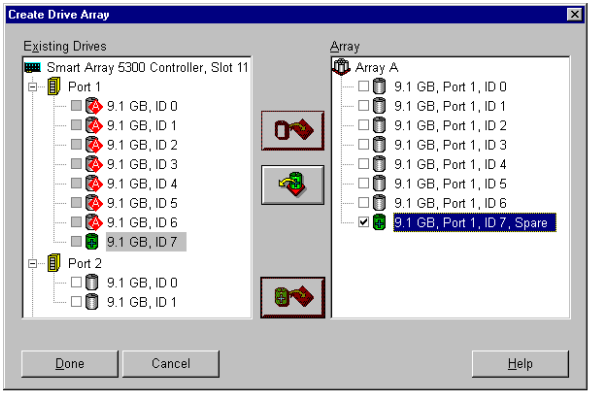


Figure 7-16: Example Array A with Spare

5. Click **Done** to return to the main ACU screen.

The **Logical Configuration View** window now looks like Figure 7-17.

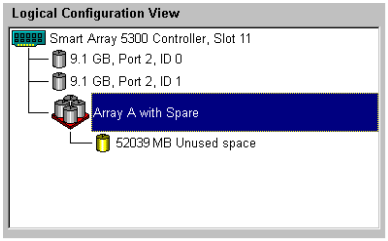


Figure 7-17: Logical Configuration View of Example Array

6. Select the controller icon, and then click **Create Array** to create Array B.
7. Repeat the previous steps to assign both remaining 9.1-GB drives to array B.
8. Click **Done** to return to the main ACU screen.

In this example, each array was created using drives from the same SCSI port. You can get better performance by installing the correct capacity drives in other ports before running the ACU, and then selecting drives from more than one port to build the array.

Creating One or More Logical Drives on the Array

1. Select the **Array A** icon or the **Unused Space** icon under Array A in the **Logical Configuration View** window (Figure 7-17).
2. Click **Create Logical Drive** in the **Array** box.
3. On the **Create Logical Drive** screen (Figure 7-11), select **RAID 5.**
4. Select **Enable,** if this radio button is active.
5. Change the stripe size, if desired (and if possible for your controller model).
6. The default values in the **Logical Drive Size** box create a single logical drive on the array. For this example, accept the default values.
7. Click **Done** to return to the main ACU screen.
8. Save the new settings by clicking **Controller** on the menu bar and selecting **Save Configuration.**

9. Create a logical drive on Array B:
   a. Select the **Array B** icon or the **Unused Space** icon under Array B in the **Logical Configuration View** window.
   b. Repeat steps 2 through 7. This time, select RAID 1+0 as the fault-tolerance method in step 3.
   c. Save the configuration, as in step 8.

The main ACU screen now looks like Figure 7-18.

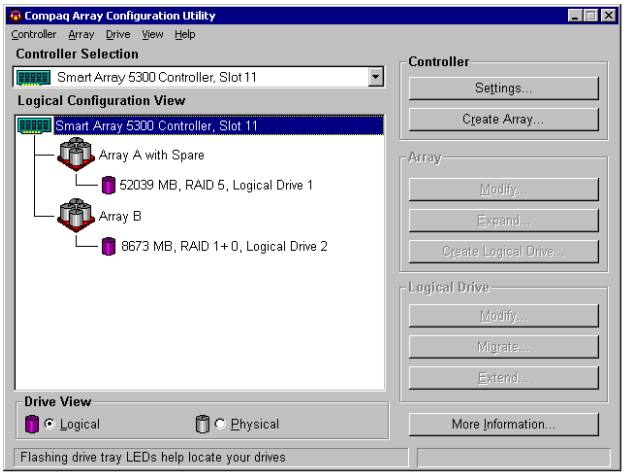


Figure 7-18: Example configuration with two arrays

NOTE: The capacity shown for each logical drive is the free capacity available for data storage. This value excludes the amount used for fault tolerance.

Expanding Array Capacity

Array capacity expansion is the addition of storage capacity to a pre-existing array. The capacity of logical drives on the array does not change, and existing data is not changed.

During capacity expansion, ACU automatically redistributes existing logical drives across all of the physical drives in the expanded array. If the array being expanded has more than one logical drive, data is redistributed one logical drive at a time. Newly created logical drives are not available until capacity expansion has finished.

CAUTION: Do not exchange the controller or array accelerator board during array capacity expansion. Interrupting expansion in this way causes irretrievable data loss.

NOTE: The expansion process takes about 15 minutes per gigabyte. Data can still be read from or written to any logical drive on the controller during an expansion, although performance might be reduced. However, a controller can perform only one expansion, extension, or migration at any given time.

There are three stages in the procedure for expanding an array:

1. Back up all data on the array. Although array expansion is unlikely to cause data loss, observing this precaution will provide additional data protection.
2. Install the new physical drives. The capacity of each new drive must be no less than that of the drives that are currently in the array.

   IMPORTANT: Do not assign a group of physical drives to the same array unless they are of the same capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and is wasted.

3. Assign the new physical drives to an existing array. When the expansion process is complete, the extra capacity can be used to increase the size of an existing logical drive (refer to the "Extending Logical Drive Capacity" section) or to create a new logical drive.

For example, consider a controller with the two arrays that were made in the example given in the "Creating a New Array" section:

- Array A—seven 9.1-GB drives in a RAID 5 configuration with a spare
- Array B—two 9.1-GB drives in a RAID 1+0 configuration without a spare

Now you install a 9.1-GB drive, and want to expand Array A to include this new drive. This scenario is represented in Figure 7-19.

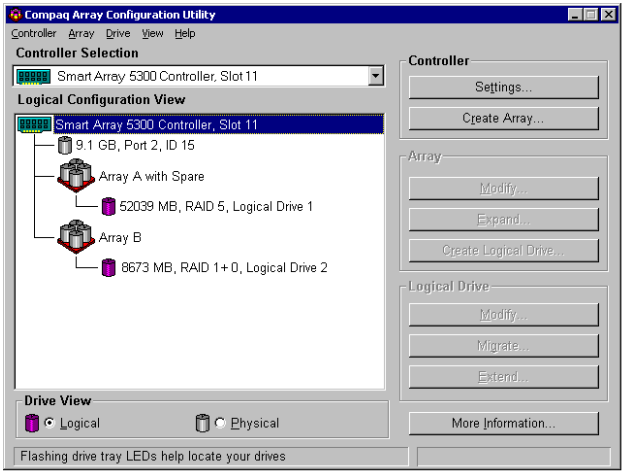


Figure 7-19: Starting an array expansion

To expand Array A and create a second logical drive on this array:

1. Select Array A in the **Logical Configuration View** window.
2. Click **Expand** in the **Array** box.
3. In the left-hand panel of the **Expand Array A** window, select the unassigned 9.1-GB drive.
4. Click the button in the middle of the screen (**Assign Drive to Array**).
5. Click **Next.** The screen shown in Figure 7-20 is displayed.

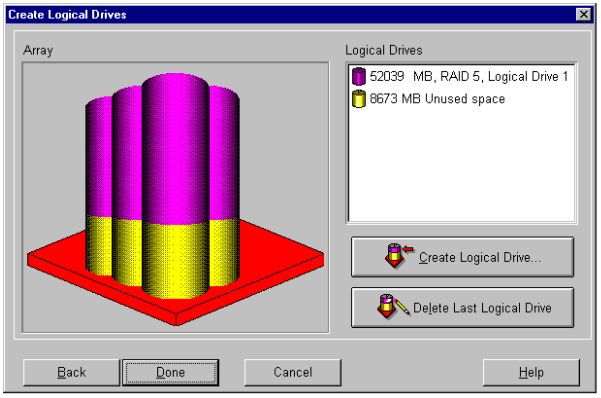


Figure 7-20: Create Logical Drives screen

6. Click **Create Logical Drive.**
7. Set the fault tolerance, stripe size, array accelerator, and size for the second logical drive that you want to create on Array A.
8. Click **Done** to return to the **Create Logical Drives** screen.
9. Click **Done** again to return to the main ACU screen.
10. On the menu bar, select **Controller, Save Configuration.** The settings for the new logical drive are saved and the capacity expansion process begins.

NOTE: The new logical drive is not built until after the controller has finished the capacity expansion process on Array A. This takes about 15 minutes per gigabyte. Data can still be read from or written to any other existing logical drive on the controller, although performance might be reduced. However, a controller can perform only one expansion, extension, or migration at any given time.

Extending Logical Drive Capacity

Logical drive capacity extension is the addition of storage capacity to an existing logical drive. For logical drive extension to be possible, sufficient free capacity must exist on the array. If necessary, create free capacity by deleting existing logical drives on the array or by performing an array expansion (for details, refer to “Expanding Array Capacity”).

The Windows NT 4.0 operating system supports **online** logical drive capacity extension. Some operating systems also support **offline** capacity extension. Before extending logical drives, check the operating system documentation for current information, or contact your operating system vendor.

NOTE: The extension process takes about 15 minutes per gigabyte. Data can still be read from or written to any logical drive on the controller during an extension, although performance might be reduced. However, a controller can perform only one expansion, extension, or migration at any given time.

To extend the capacity of a logical drive:

1. Back up all data on the array. Although array expansion is unlikely to cause data loss, observing this precaution will provide additional data protection.
2. If you are extending the capacity while offline:
   a. Restart the server from the software CD provided in the controller kit.
   b. Open ACU from the CD.
3. Select the logical drive in the **Logical Configuration View** window.
4. Click **Extend** in the **Logical Drive** box.

   The **Extend Logical Drive** screen displays the current capacity and overhead of the selected logical drive. The unshaded region on the slider scale shows the free capacity on the array that is available for extension.
5. Move the slider control to increase the size of the logical drive.

   NOTE: You cannot reduce the size of the logical drive from this screen.
6. Click **Done** to return to the main ACU screen.
7. To save the logical drive settings, click **Controller** on the menu bar and select **Save Configuration.**

   A progress bar in the lower right-hand corner of the screen shows the status of the extension process.

8. Make the extra capacity of the logical drive available to the operating system by one of the following methods:
   - — Create a new partition in the logical drive by using the operating system partitioning software.
   - — Increase the size of an existing partition by using the operating system partitioning software or third-party partitioning tools.

Migrating RAID Level or Stripe Size

NOTE: Before migrating the stripe size, check that the memory available to the array accelerator is no smaller than the lowest common multiple of the total stripe sizes of the two different configurations.

For example, consider the change from an 11-drive RAID 5 logical volume to a 14-drive RAID 1+0 logical volume. If each configuration uses the corresponding default stripe width, the block size changes from 16 kbytes per stripe to 128 kbytes per stripe.

- A full stripe in the RAID 5 configuration contains 160 kbytes (ten of the drives contain user data; one drive contains parity data).
- A full stripe in the RAID 1+0 configuration contains 896 kbytes.

The lowest common multiple of the two stripe sizes is 4480 kbytes, and this figure represents the minimum amount of memory that must be available to the array accelerator.

To migrate to a different RAID level or stripe size:

1. Back up all data on the logical drive. Although migration is unlikely to cause data loss, observing this precaution provides extra security. The backup data may also be needed if the number of sectors needs to be increased (this fact will be determined in step 8).
2. Check that the array accelerator batteries (if present) are fully charged.

   NOTE: The migration process takes about 15 minutes per gigabyte. Data can still be read from or written to any logical drive on the controller during a migration, although performance might be reduced. However, a controller can perform only one expansion, extension, or migration at any given time.

3. If your controller has a battery-backed write cache, check the **Controller Settings** screen in ACU to confirm that the write cache is enabled.
4. Select the logical drive in the **Logical Configuration View** window.

5. Click **Migrate** in the **Logical Drive** box.
6. Change the RAID level by selecting the appropriate check box.
7. Change the stripe size (Table 7-3 gives the optimum stripe size for specific situations).
8. Click **Done** to return to the main ACU screen.

   If you get a message stating that the number of sectors needs to be increased:

   a. Delete the old logical volume.

   b. Reconfigure the array as a new logical volume with the new fault-tolerance method and stripe size that you had selected.

   c. Copy the backed-up data (from step 1) into the new logical volume.
9. To save the new settings, click **Controller** on the menu bar and select **Save Configuration.**

Using CPQONLIN

The NetWare Online Array Configuration utility (CPQONLIN) lets you configure your drive arrays without shutting down your server. It also indicates when a drive attached to the array controller has failed, is undergoing expansion, or is waiting (queued) for expansion or rebuild.

To install CPQONLIN:

1. Load CPQRAID.HAM from the SmartStart CD, or from the Controller Support Software CD and diskettes. (Detailed instructions are given in the README file on the CD.)
2. Load CPQONLIN.NLM from the same source.
3. Open CPQONLIN.NLM and follow the on-screen instructions.

Running CPQONLIN

1. Enter `cpqonlin` at the console prompt.
2. Use the arrow keys to highlight **Array Configuration Utility,** and then press the **Enter** key.
3. From the list of controllers that is presented, select the one that you want to configure.
   - — If no logical drives are configured for the controller, the auto-configuration wizard screen (Figure 7-21) is displayed.
   - — If logical drives are present on the controller, the manual configuration screen (Figure 7-22) is displayed.

   Press the **F1** key for online help at any time on either screen.

Automatic Configuration

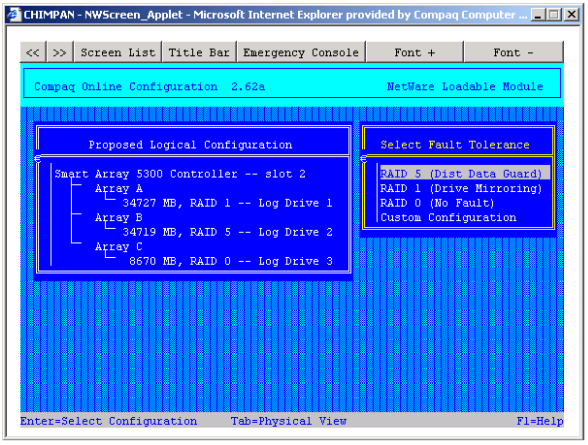


Figure 7-21: CPQONLIN auto-configuration wizard screen

1. If the proposed logical configuration shown on the wizard screen is acceptable, highlight the fault tolerance level that you want for the logical drive and press the **Enter** key. Otherwise, select **Custom Configuration** and continue the procedure as described in the “Manual Configuration” section.

2. Press the **Esc** key to save the changes and return to the controller selection screen.
3. Restart the system to apply the changes.

NOTE: Raw logical drives are invisible to the operating system. To make the new logical drives available for data storage, format the logical drive using the instructions given in your operating system documentation.

Manual Configuration

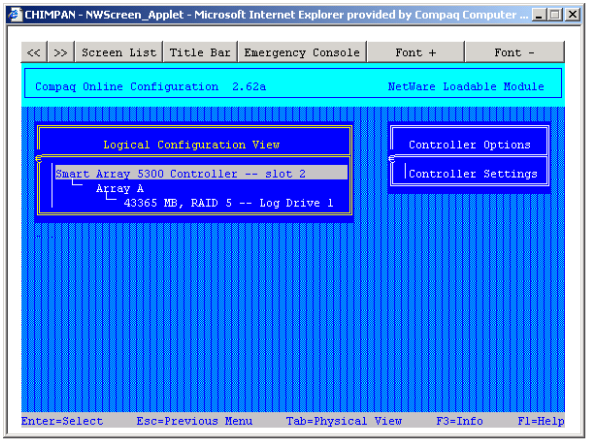


Figure 7-22: Main manual configuration screen

Highlight the controller, array, or logical drive that you want to configure, and then press the **Enter** key. The menu options for that item are shown in the panel on the right-hand side of the screen. Table 7-4 lists the menu options for each item in the **Logical Configuration View** panel. If an option is not applicable in any particular case, it is not displayed in the panel.

Table 7-4: Menu Options in CPQONLIN

CONTROLLER OPTIONS Menu		
Controller Settings	Rebuild Priority	
	Expand Priority	
	Accelerator Ratio	
Create New Array	Create Array	Assign Drive
		Assign Array
		Remove Drive
		Accept Changes
	Physical Drives	(Panel shows spare drives and unassigned hard drives attached to the controller)
	New Array	(Panel shows physical view of new array)
ARRAY OPTIONS Menu		
Expand Array	Expand Array	Assign Drive
		Accept Changes
	Physical Drives	(Panel shows spare drives and unassigned hard drives attached to the controller)
	New Array	(Panel shows physical view of new array)
Assign Spare	Assign Spare	Assign Drive
		Accept Changes
	Physical Drives	(Panel shows spare drives and unassigned hard drives attached to the controller)
	New Array	(Panel shows physical view of new array)
Delete Entire Array		
LOGICAL DRIVE OPTIONS Menu		
Drive Settings	Fault Tolerance	
	Stripe Size	

Typical Manual Configuration Procedures in CPQONLIN

Creating a Custom Configuration for a New Array

1. In the **Logical Configuration View** panel, highlight the controller that you want to configure and then press the **Enter** key.
2. Choose **Create New Array** in the **Controller Options** panel, and then press the **Enter** key.

   The screen now displays three panels: **Create Array, Physical Drives,** and **New Array.**
3. Choose **Assign Drive** in the **Create Array** panel, and then press the **Enter** key.

   The highlight automatically moves to the **Physical Drives** panel.
4. Select a drive and then press the **Enter** key.

   IMPORTANT: Do not assign a group of physical drives to the same array unless they are of the same capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and is wasted.

   The **New Array** panel lists the added drive, and the highlight automatically returns to the **Create Array** panel.
5. Repeat steps 3 and 4 until you have finished assigning drives to the array.

   NOTE: You can add spare drives to the array only when all data storage drives have been assigned.
6. Choose **Accept Changes** and press the **Enter** key.

   The main manual configuration screen is displayed again.

Adding Spare Drives

To add spare drives to an array, the array controller must have at least one attached drive that is either unassigned or is assigned as a spare to another array.

You can:

- Assign a different online spare to each array on the controller.
- Share one online spare among several arrays on the same controller, for efficient use of drive capacity.
- Assign several online spares to just one array.
- Share several online spares among several arrays; this method provides the greatest amount of protection for the largest number of arrays.

IMPORTANT: Assigning several spares to an array lets you postpone replacement of faulty drives, but it does **not** increase the fault-tolerance level of any logical drives in the array. For example, a logical drive in a RAID 5 configuration suffers irretrievable data loss if two physical drives fail simultaneously, regardless of the number of spare drives assigned.

Any drive that you assign as an online spare for an array operates as the spare for every fault-tolerant logical drive within the array.

When you select **Assign Spare**, only drives that qualify will be displayed; for example, drives with too small a capacity are not listed. If a drive that you expect to see is not listed, press the **Tab** key (to switch to the physical drive view) and check the capacity of the drive.

To add a spare:

1. In the **Logical Configuration View** panel, highlight the array that needs a spare, and then press the **Enter** key.
2. Choose **Assign Spare** in the **Array Options** menu, and then press the **Enter** key.
3. Select the drive that you want as the spare, and then press the **Enter** key.
4. Press the **Esc** key to accept the new configuration and return to the main manual configuration screen.

Configuring the New Logical Drive

1. In the **Logical Configuration View** panel, highlight the new logical drive that you want to configure, and then press the **Enter** key.
2. Select **Fault Tolerance** in the **Logical Drive Options** menu, and then press the **Enter** key.
3. Choose the RAID level that you want and then press the **Enter** key.
4. Choose **Stripe Size** and then press the **Enter** key.
5. Choose the stripe size that you want and then press the **Enter** key.
6. Press the **Esc** key to accept the settings and return to the main manual configuration screen.

Configuring the Controller Settings

The **Controller Settings** option allows you to choose the drive rebuild priority, expansion priority, and accelerator ratio for all arrays on the controller.

- With a **low** priority setting, a rebuild or expansion takes place only when the array controller is not busy handling normal I/O requests. This setting has minimal effect on normal I/O operations. However, there is an increased risk that data will be lost if another physical drive fails while the rebuild is in progress.
- With a **high** priority setting, the rebuild or expansion occurs at the expense of normal I/O operations. Although performance is affected, this setting provides better data protection because the array is vulnerable to additional drive failures for a shorter time.

NOTE: Logical drives can be rebuilt only if they are configured for fault tolerance (RAID 1+0, RAID 5, or RAID ADG). Drive rebuild begins automatically after you have replaced a failed physical drive in the array.

The accelerator read/write ratio determines the amount of memory allocated to the read and write caches on the array accelerator. Different applications have different optimum settings. Some controllers (especially those without battery-backed write cache) do not allow this ratio to be changed.

1. In the **Logical Configuration View** panel, select the controller that you want to configure, and then press the **Enter** key.
2. Select **Controller Settings** in the **Controller Options** panel, and then press the **Enter** key. The controller settings screen is displayed.

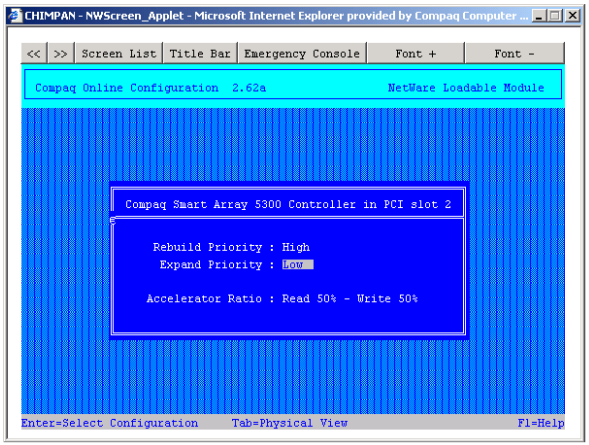


Figure 7-23: Controller settings screen

3. Alter the settings on this screen to suit your needs.
4. Press the **Esc** key to save the new configuration.
5. Exit CPQONLIN, and then restart the system to apply the changes.

Expanding an Array

Performance may be degraded slightly during array expansion, depending on the **Expand Priority** setting. To minimize any effect, expand the array during periods of low server use.

NOTE: The expansion process takes about 15 minutes per gigabyte. The controller is not able to expand or migrate any other logical drive during this time. Instead, further requests for expansion or migration are queued.

1. Back up all data on the logical drive. Although array expansion is unlikely to cause data loss, observing this precaution provides extra security.

2. Check that the array accelerator batteries (if present) are fully charged.
3. In the **Logical Configuration View** panel, select the array that you want to expand, and then press the **Enter** key.
4. Select **Expand** in the menu, and then press the **Enter** key.
5. Select the hard drive that you want to add to the array, and then press the **Enter** key.

   IMPORTANT: Do not assign a group of physical drives to the same array unless they are of the same capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and is wasted.

6. Repeat step 5 until you have finished adding drives.
7. Select **Accept Changes,** and then press the **Enter** key.
8. Press the **Esc** key to begin the array expansion.

   You can see the progress of the expansion at any time by pressing the **F3** key and then scrolling to the progress bar near the bottom of the screen.

Migrating RAID Level or Stripe Size

Performance may be degraded slightly during migration, depending on the **Expand** (or **Rebuild**) **Priority** setting. To minimize any effect, migrate during periods of low server use.

NOTE: The migration process takes about 15 minutes per gigabyte. The controller is not able to expand or migrate any other logical drive during this time. Instead, further requests for expansion or migration will be queued.

1. Back up all data on the logical drive. Although migration is unlikely to cause data loss, observing this precaution provides extra security.
2. Check that the array accelerator batteries (if present) are fully charged.
3. In the **Logical Configuration View** panel, select the logical drive that you want to migrate and then press the **Enter** key.
4. Select **Drive Settings,** and then press the **Enter** key.
5. Change the RAID level or stripe size shown on this screen.

6. Press the **Esc** key to accept the changes and begin migration.

   You can check the progress of the migration at any time by pressing the **F3** key and then scrolling to the progress bar near the bottom of the screen.

8

Installing the Device Drivers

The drivers for the controller are located on the Smart Array Controller Support Software CD and on the SmartStart CD. Updates are posted to www.compaq.com.

Using the Smart Array Controller Support Software CD

Instructions for installing the drivers from the Smart Array Controller Support Software CD are given in the leaflet provided with the CD. Note that the exact procedure depends on whether the server is new, or already contains the operating system and user data.

Using the SmartStart CD

If you are setting up a **new** server, the drivers are installed and configured at the same time that you install the operating system. Refer to the documentation provided with the CD for the operating system installation instructions.

If you are adding the controller to an **existing system,** you must create Compaq Support Paq diskettes (CSPs) for the operating system that you use. These diskettes contain the operating system software, drivers, and support documentation.

To create CSPs:

1. Insert the SmartStart CD into the CD-ROM drive tray of a server with a bootable CD-ROM drive. The server does not need to be the one in which you are going to install the controller.
2. Restart the server.
3. On the **Compaq System Utilities** screen, select **Create Support Software.**
4. On the **Diskette Builder** screen, select **Create Support Software From CD Only.**
5. Scroll down the list and select the support software for the operating system that you are using.
6. Follow the on-screen instructions to create the diskettes. Depending on your operating system, you may need to use up to six blank diskettes.

Detailed instructions for installing the device drivers are given in the README files on the CSPs.

Updating the Compaq Insight Manager Agents

If you are installing the controller as additional storage, you may now update the Compaq Insight Manager agents if new versions are available. Refer to the documentation that is included with Compaq Insight Manager for the correct procedure to update the agents.

You can obtain the Compaq Insight Manager Agents from your local Compaq reseller or Compaq authorized service provider. The latest versions of Compaq Insight Manager and Management Agents are also available for download at www.compaq.com/manage.

If the new agents do not function correctly, you may also need to update Compaq Insight Manager.

9

Upgrading and Replacing Options

Array Accelerator

To remove the existing array accelerator board:

1. Squeeze the ends of the heat sink clip inwards (1), and then rotate the clip out of the heat sink (2).

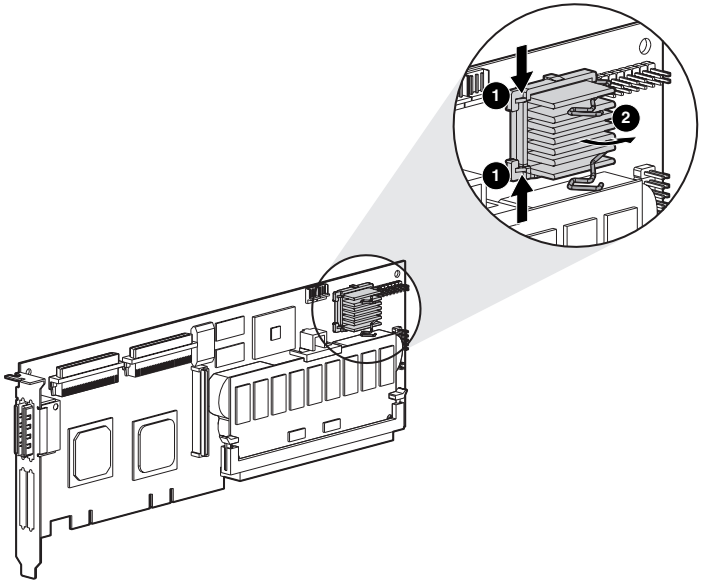


Figure 9-1: Removing the heatsink

2. Lift the heatsink out of the frame.

3. Rotate the clip back towards the controller board to allow room for the array accelerator board to be removed.
4. Remove the plastic retainer (1) by detaching it from the array accelerator and unhooking it from the controller board.

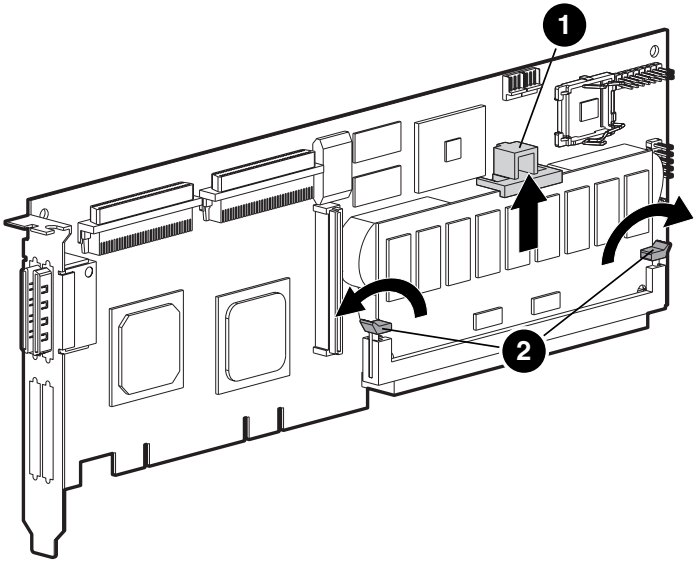


Figure 9-2: Releasing the array accelerator board

5. Swing out the DIMM ejectors (2) on each side of the array accelerator.
6. Tilt the array accelerator slightly away from the controller board (angle exaggerated in the figure for clarity), and then unplug the array accelerator from the DIMM socket on the controller board.

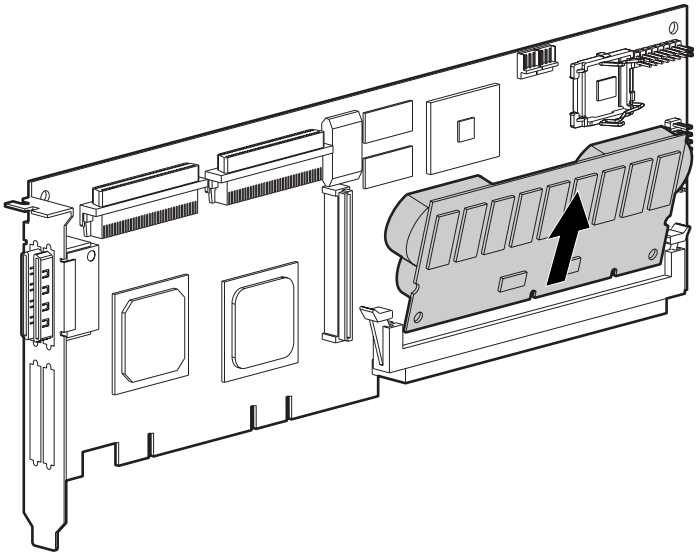


Figure 9-3: Unplugging the array accelerator board

To install the new array accelerator board:

1. Push the array accelerator board firmly into the DIMM connector socket.
2. Close the DIMM ejector levers to lock the array accelerator into place.
3. Reinstall the plastic retainer.
4. Reattach the heatsink.

Installation of the new array accelerator board is complete.

Battery Pack

WARNING: There is a risk of explosion, fire, or personal injury if the battery pack is replaced incorrectly or mistreated. To reduce the risk:

- **Do not attempt to recharge the battery outside of the controller.**
- **Do not expose to water, or to temperatures higher than 60°C (140°F).**
- **Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.**
- **Replace only with the Compaq spare designated for this product.**

Battery or array accelerator disposal should comply with local regulations. Alternatively, return these parts by established parts return methods to Compaq Computer Corporation for disposal.

To remove the old NiMH battery pack:

1. Push down on the battery pack clip, located near the lower corner of the array accelerator.

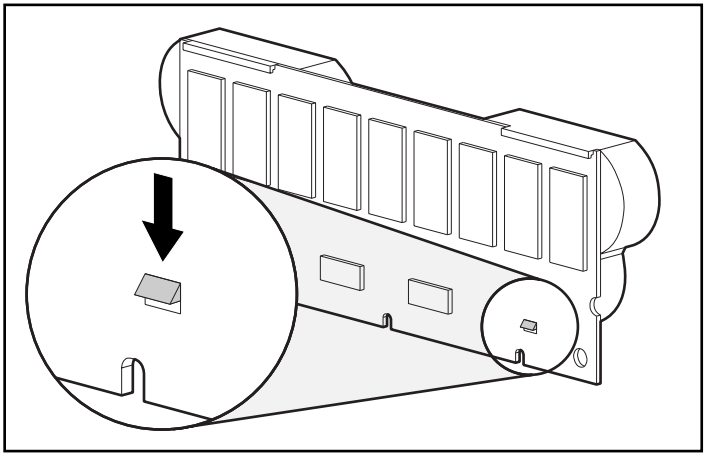


Figure 9-4: Clip on battery pack

2. Rotate the battery pack away from the array accelerator board by an angle of 10 degrees.

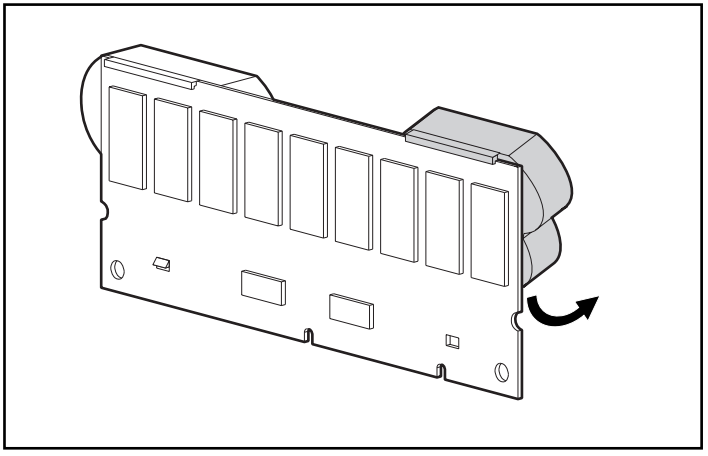


Figure 9-5: Releasing the battery pack

3. Remove the pack from the array accelerator board. If the battery pack flange grasps the board tightly, rock the pack slightly from side to side while lifting the pack upward.

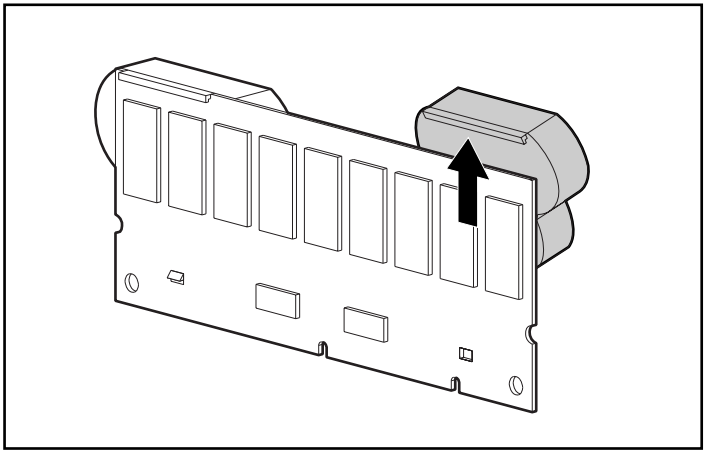


Figure 9-6: Removing the battery pack

Since both packs are likely to be discharged at a similar rate, repeat the procedure for the other battery pack.

To install a new NiMH battery pack:

1. Wait about 15 seconds after removing the old battery packs to allow the battery charge monitor to reset.
2. Hook the battery pack flange onto the top of the array accelerator board, with the pack held at a 10-degree angle to the plane of the board.

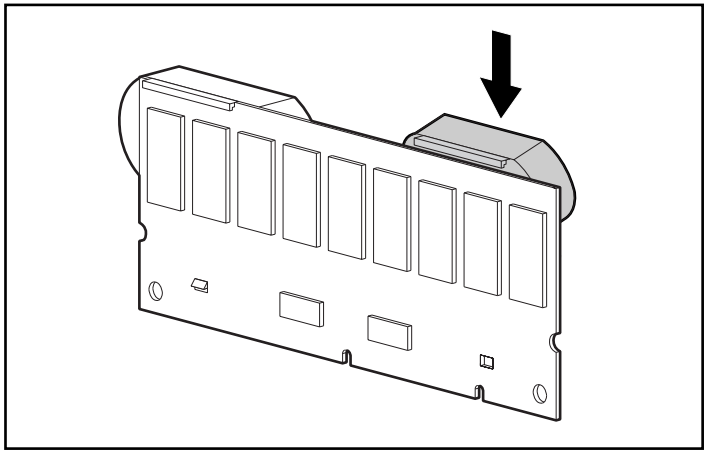


Figure 9-7: Installing the new battery pack

3. Rotate the battery pack towards the array accelerator board. Be sure that the clip and two pegs line up with the corresponding holes in the array accelerator board, and then press the battery pack firmly to lock it securely in place.
4. Confirm that the flange (1) and clip (2) are securely attached to the array accelerator board.

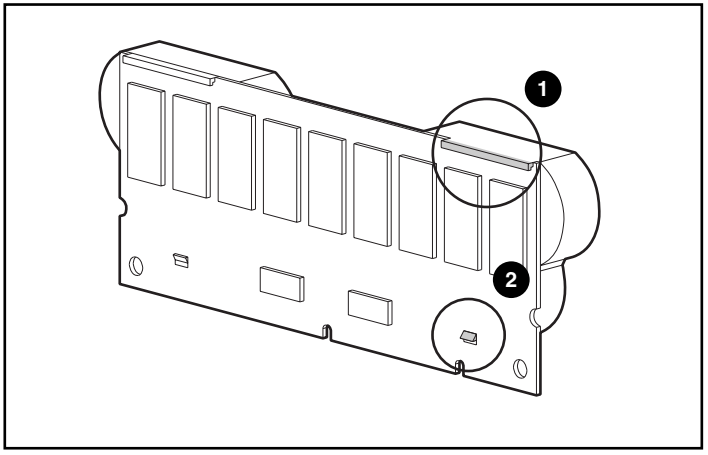


Figure 9-8: Securing the flange and clip

Installation of the new battery pack is complete. Repeat for the other battery pack.

2- to 4-Channel Adapter Board

To remove the existing 2- to 4-channel adapter board:

1. Remove the screw that secures the 2- to 4-channel adapter board. This screw is reachable from the back of the controller board.

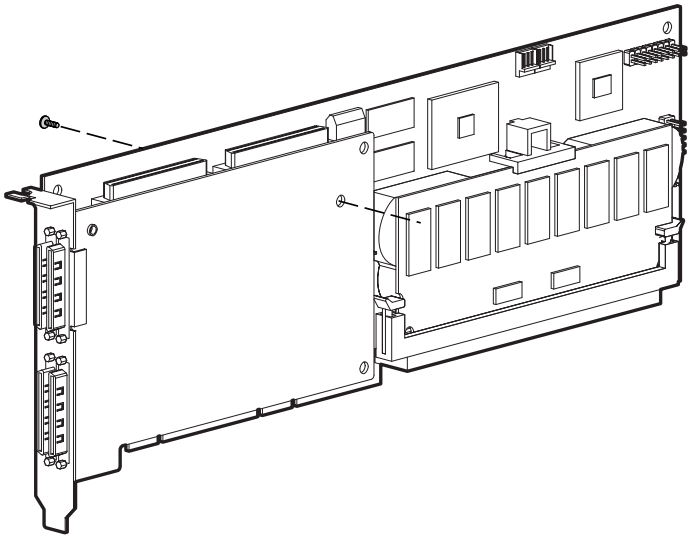


Figure 9-9: Removing the securing screw

2. Unplug the 2- to 4-channel adapter board from the connector on the controller board.

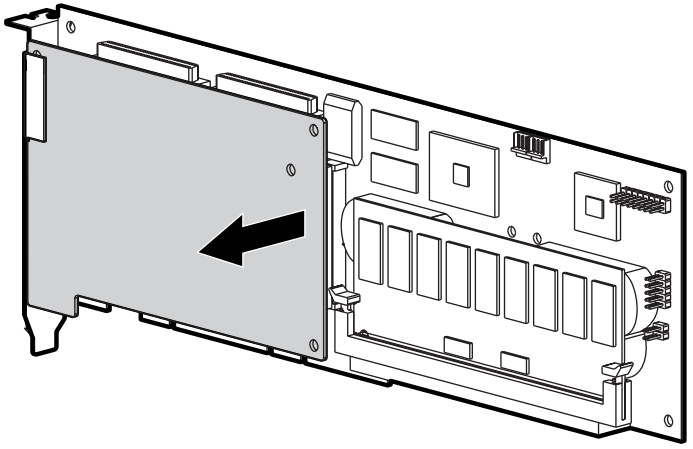


Figure 9-10: Unplugging the 2- to 4-channel adapter board

3. Pull the 2- to 4-channel adapter board out of the VHDCI socket.

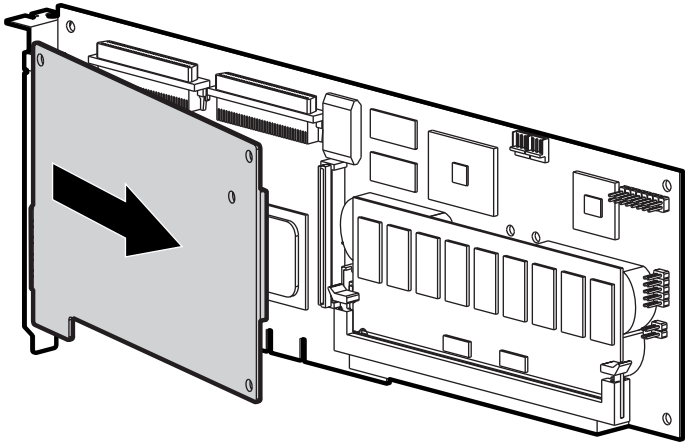


Figure 9-11: Removing the 2- to 4-channel adapter board

To install the new 2- to 4-channel adapter board:

1. Insert the VHDCI connector on the adapter board into the unoccupied VHDCI slot (1) while sliding the adapter board under the bracket lip (2) on the occupied VHDCI slot.

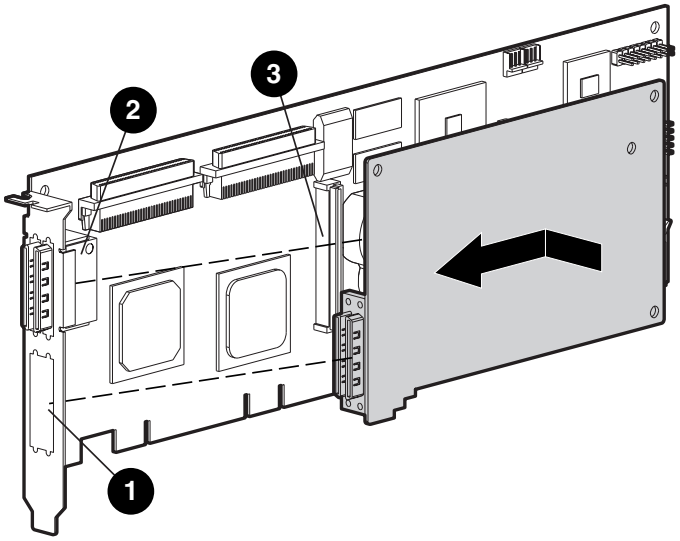


Figure 9-12: Installing the adapter board

2. Plug the adapter board into the connector (3) on the controller board.
3. Secure the adapter board to the controller board by inserting and tightening the appropriate screw (included in the kit) in the back of the controller board.

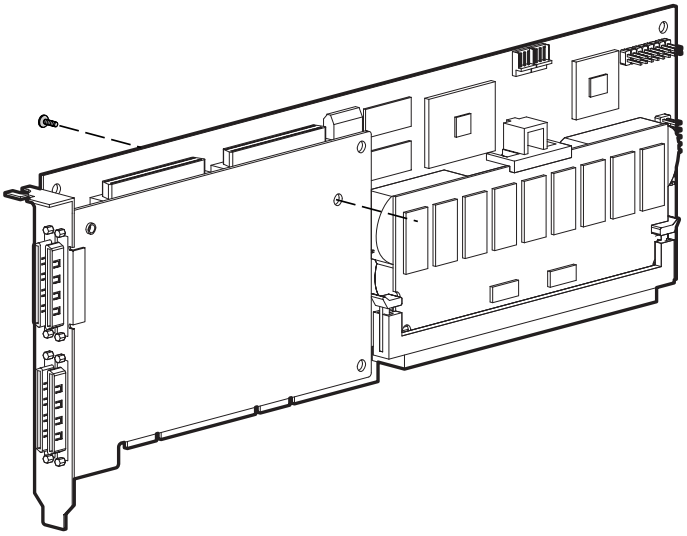


Figure 9-13: Securing the adapter board to the array controller board

Installation of the new adapter board is complete.

Enabling RAID ADG

You can enable RAID ADG on a Smart Array 5300 Controller by installing a software key. Alternatively, if you have an older version of the controller, you can install a hardware enabler module on the controller board.

Using the Software Key

1. Confirm that the array accelerator has a capacity of at least 64 MB.
2. Close all applications and utilities on the server containing the controller.
3. Insert the CD from the RAID ADG option software kit into the CD-ROM drive.
4. Reboot the server.
5. If necessary, upgrade the controller firmware to the version provided on the CD, and then reboot the server. (This step is required, for example, if the controller is a Smart Array 5300 with a current firmware version less than 2.72.)

   NOTE: If the firmware on the controller is newer than that on the CD, the flash utility does not replace it with the earlier firmware from the CD.

6. Select **Array Configuration Utility XE** from the CD menu.

   This action opens ACU-XE, the browser-based version of the Compaq Array Configuration Utility (ACU).

   IMPORTANT: Use the version of ACU-XE that is provided on the CD. The software key cannot be installed using versions of ACU-XE earlier than 1.40, nor can it be installed using ACU.

7. When the utility has loaded, select the controller that is to be used to configure RAID ADG.
8. Select **License Key Management.**
9. Select **Enter License Key.**
10. Enter the 25-character license key (provided on the CD sleeve) and click **Submit.**

    If you wish, you can now configure the controller using ACU-XE.

11. Exit ACU-XE, remove the CD, and reboot the server.

For further instructions or clarifications regarding the software key installation procedure, refer to the ACU-XE online help.

Using the Enabler Module

The connector for the RAID ADG Enabler Module is located at the corner of the controller board near the array accelerator connector socket, as shown in Figure 9-14. The module attaches to the controller board with the narrow tab (circled in Figure 9-15) nearest to the corner of the controller board. This tab can be pressed outwards during installation to allow the module to be more readily inserted into the board. The clips at each end of the module fit into the slots on the board.

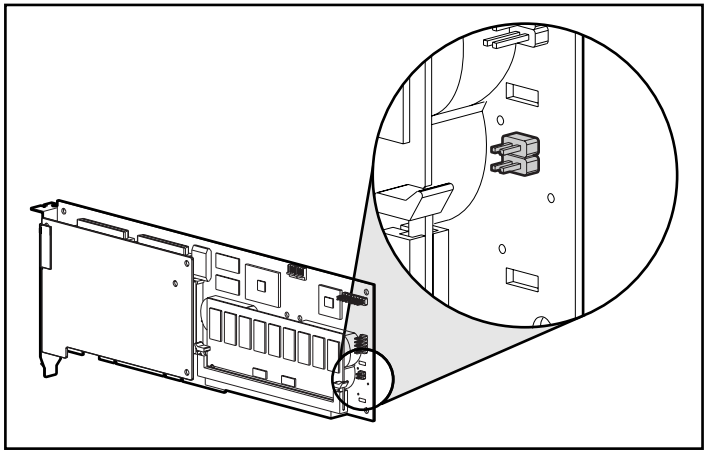


Figure 9-14: Location of the RAID ADG Enabler Module connector on the Smart Array 5300 Controller board

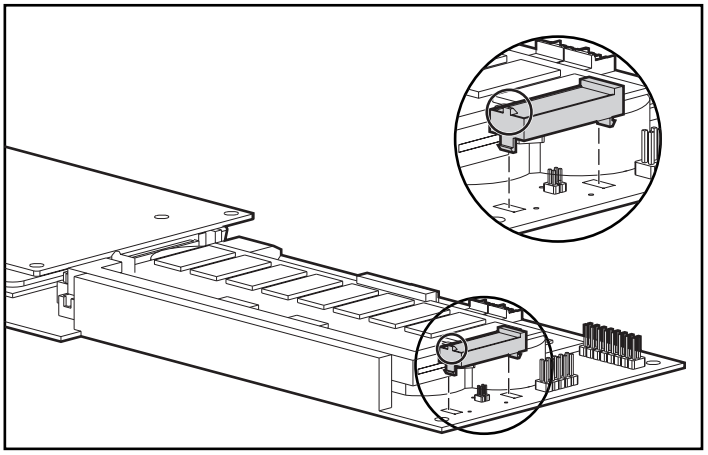


Figure 9-15: Aligning the module on the controller board

When replacing a Smart Array 5300 Controller, you may want to remove the RAID ADG Enabler Module from the old controller and install it onto the new controller.

To remove the RAID ADG Enabler Module:

Press the innermost plastic clip under the controller board towards the other clip (1), and push the module out of the board (2).

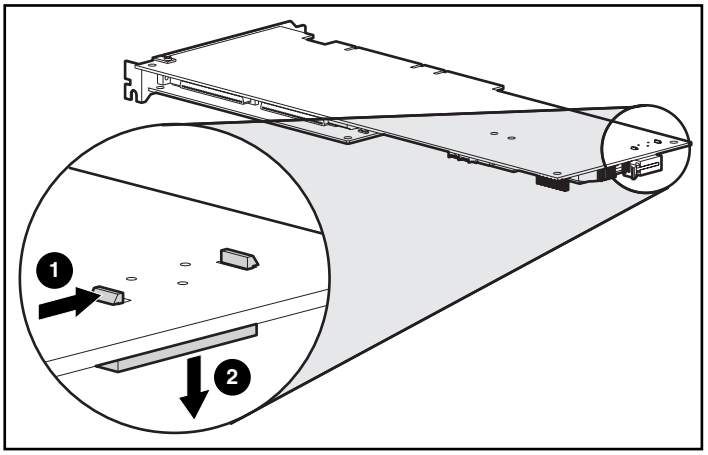


Figure 9-16: Removing the RAID ADG Enabler Module

To install the module on the new controller board:

1. Check that the array accelerator on the new controller board has at least 64 MB of read/write cache.
2. Hold the module at an angle and insert the rear end of the module into the appropriate slot (1).

3. Use one thumb to press the tab at the top of the rear end outward (2a), while using the other thumb to **gently** press the other end of the module (2b) into the connector and slot on the controller board.

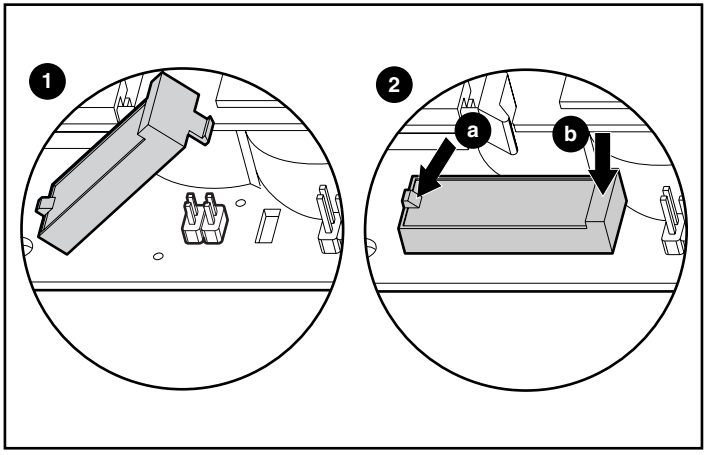


Figure 9-17: Installing the module

Installation of the RAID ADG Enabler Module is complete.

A

Regulatory Compliance Notices

Regulatory Compliance Identification Numbers

For the purpose of regulatory compliance certifications and identification, your product has been assigned a unique Compaq series number. The series number can be found on the product nameplate label, along with all required approval markings and information. When requesting compliance information for this product, always refer to this series number. The series number should not be confused with the marketing name or model number of the product.

Federal Communications Commission Notice

Part 15 of the Federal Communications Commission (FCC) Rules and Regulations has established Radio Frequency (RF) emission limits to provide an interference-free radio frequency spectrum. Many electronic devices, including computers, generate RF energy incidental to their intended function and are, therefore, covered by these rules. These rules place computers and related peripheral devices into two classes, A and B, depending upon their intended installation. Class A devices are those that may reasonably be expected to be installed in a business or commercial environment. Class B devices are those that may reasonably be expected to be installed in a residential environment (for example, personal computers). The FCC requires devices in both classes to bear a label indicating the interference potential of the device as well as additional operating instructions for the user.

The rating label on the device shows the classification (A or B) of the equipment. Class B devices have an FCC logo or FCC ID on the label. Class A devices do not have an FCC logo or FCC ID on the label. After the Class of the device is determined, refer to the corresponding statement in the following sections.

Class A Equipment

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at personal expense.

Class B Equipment

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit that is different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

Declaration of Conformity for Products Marked with the FCC Logo, United States Only

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

For questions regarding your product, contact us by mail or telephone:

- Compaq Computer Corporation
  P. O. Box 692000, Mail Stop 530113
  Houston, Texas 77269-2000
- 1-800-652-6672 (1-800-OK COMPAQ) (For continuous quality improvement, calls may be recorded or monitored.)

For questions regarding this FCC declaration, contact us by mail or telephone:

- Compaq Computer Corporation
  P. O. Box 692000, Mail Stop 510101
  Houston, Texas 77269-2000
- 1-281-514-3333

To identify this product, refer to the part, series, or model number found on the product.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Compaq Computer Corporation may void the user's authority to operate the equipment.

Cables

Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods in order to maintain compliance with FCC Rules and Regulations.

Canadian Notice (Avis Canadien)

Class A Equipment

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Class B Equipment

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Mouse Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

European Union Notice

Products with the CE Marking comply with both the EMC Directive (89/336/EEC) and the Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.

Compliance with these directives implies conformity to the following European Norms (the equivalent international standards are in parenthesis):

- EN55022 (CISPR 22) – Electromagnetic Interference
- EN55024 (IEC61000-4-2, 3, 4, 5, 6, 8, 11) – Electromagnetic Immunity
- EN61000-3-2 (IEC61000-3-2) – Power Line Harmonics
- EN61000-3-3 (IEC61000-3-3) – Power Line Flicker
- EN60950 (IEC950) – Product Safety

Japanese Notice

ご使用になっている装置にVCCIマークが付いていましたら、次の説明文をお読み下さい。

この装置は、情報処理装置等電波障害自主規制協議会（VCCI）の基準に基づくクラスB情報技術装置です。この装置は、家庭環境で使用することを目的としていますが、この装置がラジオやテレビジョン受信機に近接して使用されると、受信障害を引き起こすことがあります。
取扱説明書に従って正しい取り扱いをして下さい。

VCCIマークが付いていない場合には、次の点にご注意下さい。

この装置は、情報処理装置等電波障害自主規制協議会（VCCI）の基準に基づくクラスA情報技術装置です　この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。

Taiwanese Notice

警告使用者：

這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

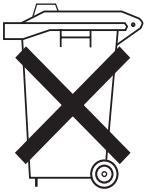
Battery Replacement Notice

The array accelerator on the controller is equipped with a nickel metal hydride (NiMH) battery pack. Replacement is to be performed by a Compaq authorized service provider using the Compaq spare designated for this product.

WARNING: There is a risk of explosion, fire, or personal injury if the battery pack is not properly handled. To reduce the risk:

- **Do not attempt to recharge the battery outside of the controller.**
- **Do not expose to water, or to temperatures higher than 60°C.**
- **Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.**
- **Replace only with the Compaq spare designated for this product.**

Battery or array accelerator disposal should comply with local regulations. Alternatively, return these parts by established parts return methods to Compaq Computer Corporation for disposal.



Batteries, battery packs, and accumulators should not be disposed of together with the general household waste. To forward them to recycling or proper disposal, please use the public collection system or return them to Compaq, your authorized Compaq Partners, or their agents.

For more information about battery replacement or proper disposal, contact your Compaq authorized reseller or your authorized service provider.

B

Electrostatic Discharge

To prevent damaging the system, be aware of the precautions you need to follow when setting up the system or handling parts. A discharge of static electricity from a finger or other conductor may damage system boards or other static-sensitive devices. This type of damage may reduce the life expectancy of the device.

To prevent electrostatic damage, observe the following precautions:

- Avoid hand contact by transporting and storing products in static-safe containers.
- Keep electrostatic-sensitive parts in their containers until they arrive at static-free workstations.
- Place parts on a grounded surface before removing them from their containers.
- Avoid touching pins, leads, or circuitry.
- Always be properly grounded when touching a static-sensitive component or assembly.

There are several methods for grounding. Use one or more of the following methods when handling or installing electrostatic-sensitive parts:

- Use a wrist strap connected by a ground cord to a grounded workstation or computer chassis. Wrist straps are flexible straps with a minimum of 1 megohm resistance in the ground cords. To provide proper ground, wear the strap snug against the skin.
- Use heel straps, toe straps, or boot straps at standing workstations. Wear the straps on both feet when standing on conductive floors or dissipating floor mats.
- Use conductive field service tools.

- Use a portable field service kit with a folding static-dissipating work mat.

If you do not have any of the suggested equipment for proper grounding, have a Compaq authorized reseller install the part.

NOTE: For more information on static electricity, or assistance with product installation, contact your Compaq authorized reseller.

C

Controller Specifications

Table C-1: Controller Specifications

Dimensions	31.5 cm × 10.8 cm × 1.5 cm (12.4 in × 4.3 in × 0.6 in)
Power required	21.2 W for 5302 (16.3 W at 3.3 V, 4.8 W at 5 V)
	24.9 W for 5304 (19.0 W at 3.3 V, 5.9 W at 5 V)
PCI Bus transfer rate	Up to 528 MB/s
SCSI Bus	
Number of channels	4 (5304), or 2 upgradeable to 4 (5302)
Number of drives per channel	Up to 14
Connector type	68-pin Wide internal, VHDCI external
Termination	Required, but provided on Compaq systems
Transfer rate	Up to 160 MB/s (40 MHz) per channel
Temperature Range	
Operating	10° to 35°C (50° to 95°F)
Shipping	-30° to 60°C (-22° to 140°F)
Relative Humidity (Non-condensing)	
Operating	20% to 80%
Non-operating	5% to 90%

D

Drive Arrays and Fault Tolerance

What Is a Drive Array?

The capacity and performance of a single physical (hard) drive is adequate for home users. However, business users demand higher storage capacities, higher data transfer rates, and greater protection against data loss when drives fail.

Connecting extra physical drives to a system increases the total storage capacity (refer to Figure D-1), but has no effect on the efficiency of read/write (R/W) operations. Data can still be transferred to only one physical drive at a time.

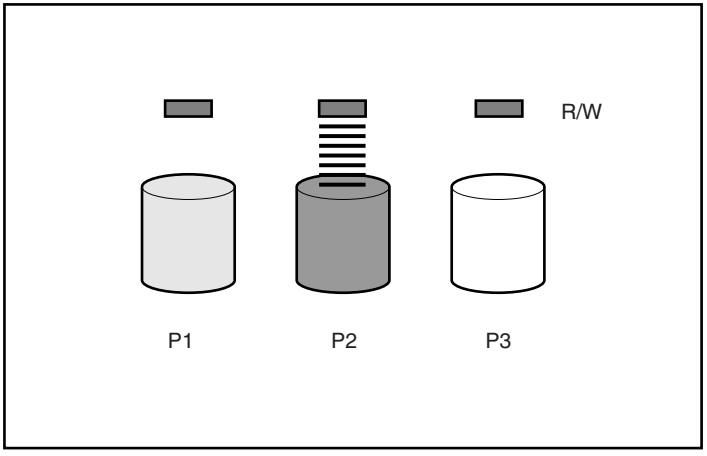


Figure D-1: Physical drives added to system

With an array controller installed in the system, the capacity of several physical drives can be combined into one or more virtual units called **logical drives** (also called logical volumes). Then, the read/write heads of all the constituent physical drives are active simultaneously, reducing the total time required for data transfer.

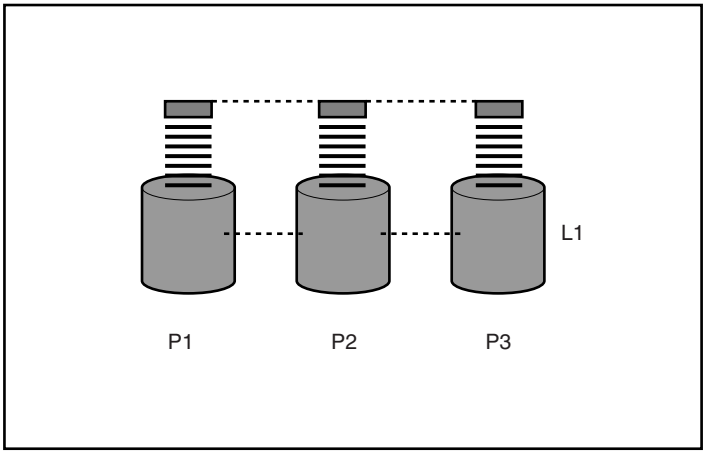


Figure D-2: Physical drives configured into a logical drive (L1)

Because the read/write heads are active simultaneously, the same amount of data is written to each drive during any given time interval. Each unit of data is called a **block,** and over all the physical drives in a logical drive the blocks form a set of data **stripes** (refer to Figure D-3).

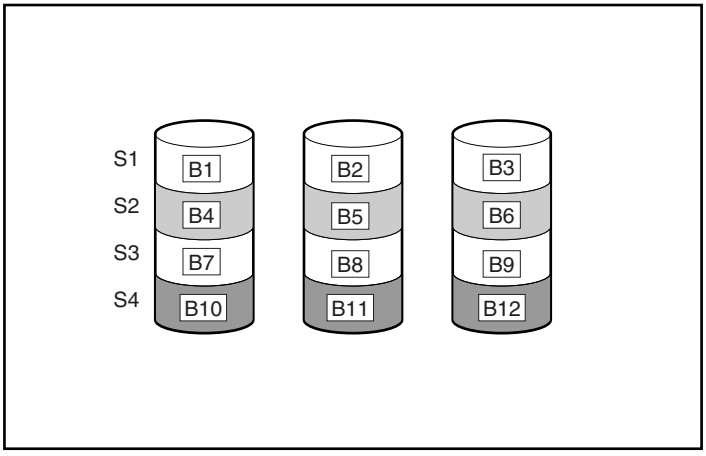


Figure D-3: Data striping (S1-S4) of data blocks B1-B12

For data in the logical drive to be readable, the data block sequence must be the same in every stripe. This sequencing process is performed by the array controller, which sends the data blocks to the drive write heads in the correct order.

A natural consequence of the striping process is that each physical drive in a given logical drive will contain the same amount of data. If one physical drive has a larger capacity than other physical drives in the same logical drive, the extra capacity is wasted because it cannot be used by the logical drive.

The group of physical drives containing the logical drive is called a **drive array** (or just **array).** Since all the physical drives in an array are commonly configured into just one logical drive, the term array is also often used as a synonym for logical drive. However, an array can contain several logical drives, each of a different size (refer to Figure D-4).

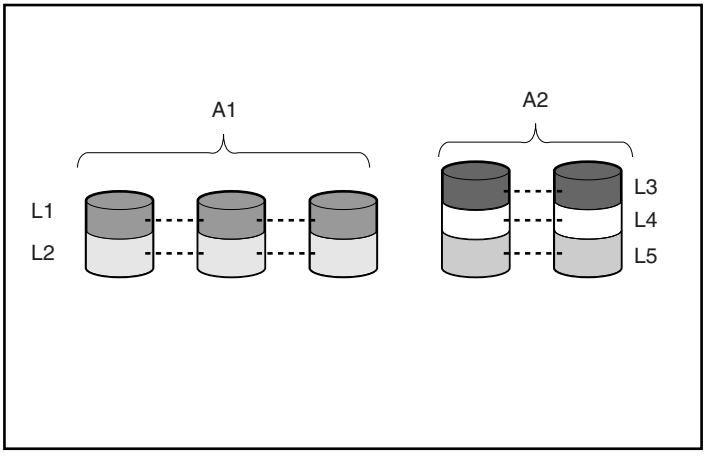


Figure D-4: Two arrays (A1, A2) containing five logical drives spread over five physical drives

Each logical drive in an array is distributed over all of the physical drives within the array. A logical drive can also extend over more than one port on the same controller, but it cannot extend over more than one controller.

Drive failure, although rare, is potentially catastrophic. In Figure D-4, for example, failure of **any** physical drive causes **all** logical drives in the same array to fail, and all data on the drives is lost.

To protect against data loss due to physical drive failure, logical drives are configured with **fault tolerance.** There are several fault-tolerance methods; those supported by current Compaq controllers (and described in the following section) are:

- RAID 0—Data Striping only (no fault tolerance)
- RAID 1+0—Drive Mirroring
- RAID 5—Distributed Data Guarding
- RAID ADG—Advanced Data Guarding

For any configuration except RAID 0, further protection against data loss can be achieved by assigning a drive as an **online spare** (or **hot spare**). This drive contains no data and is connected to the same controller as the array. When any other physical drive in the array fails, the controller automatically rebuilds information that was originally on the failed drive onto the online spare. The system is quickly restored to full RAID-level data protection. (However, in the unlikely event that another drive in the array fails while data is being rewritten to the spare, the logical drive will still fail.)

When you configure an online spare, it is automatically assigned to all logical drives in the same array. Additionally, you do not need to assign a separate online spare to each array; you can configure one hard drive to be the online spare for several arrays, as long as the arrays are all on the same controller.

Fault-Tolerance Methods

RAID 0—No Fault Tolerance

This configuration (refer to Figure D-3) provides no protection against data loss when a drive fails. However, it is useful for rapid storage of large amounts of non-critical data (for printing or image editing, for example), or when cost is the most important consideration.

Advantages

- Highest performance method for writes
- Lowest cost per unit of data stored
- All drive capacity is used to store data (none needed for fault tolerance)

Disadvantages

- All data on the logical drive is lost if a physical drive fails
- Cannot use an online spare
- Can only preserve data by backing it up to external drives

RAID 1+0—Drive Mirroring

In this configuration, data is duplicated onto a second drive.

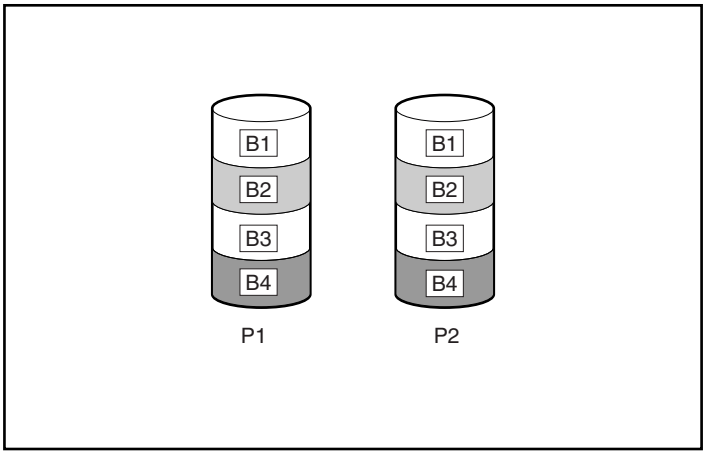


Figure D-5: Drive mirroring of P1 onto P2

When the array has more than two physical drives, drives are mirrored in pairs.

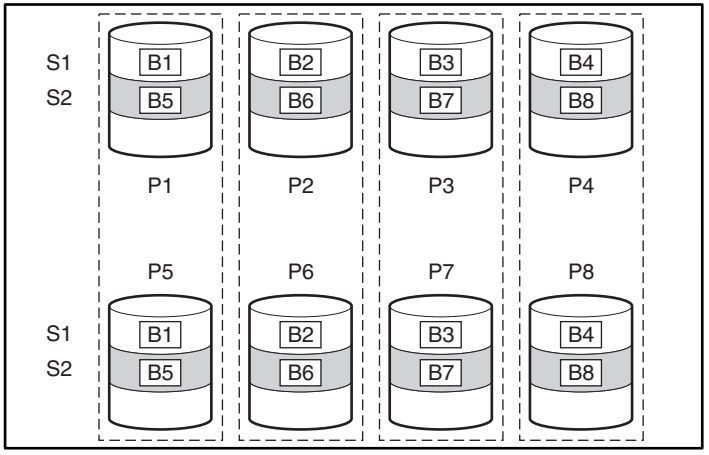


Figure D-6: Mirroring with more than two physical drives in the array

In each mirrored pair, the physical drive that is not busy answering other requests answers any read request sent to the array. (This behavior is called **load balancing.**) If a physical drive fails, the remaining drive in the mirrored pair can still provide all the necessary data. Several drives in the array can fail without incurring data loss, as long as no two failed drives belong to the same mirrored pair.

This fault-tolerance method is useful when high performance and data protection are more important than the cost of physical drives.

NOTE: When there are only two physical drives in the array, this fault-tolerance method is often referred to as RAID 1.

Advantages

- Highest read and write performance of any fault-tolerant configuration
- No loss of data as long as none of failed drives are mirrored to another failed drive (up to half of the physical drives in the array can fail)

Disadvantages

- Expensive (many drives needed for fault tolerance)
- Only 50% of total drive capacity useable for data storage

RAID 5—Distributed Data Guarding

By this method, a block of **parity data** is calculated for each stripe from the data that is in all other blocks within that stripe. The blocks of parity data are distributed over every physical drive within the logical drive (refer to Figure D-7). When a physical drive fails, data that was on the failed drive can be calculated from the user data on the remaining drives and the parity data. This recovered data is usually written to an online spare in a process called a **rebuild.**

This configuration is useful when cost, performance, and data availability are equally important.

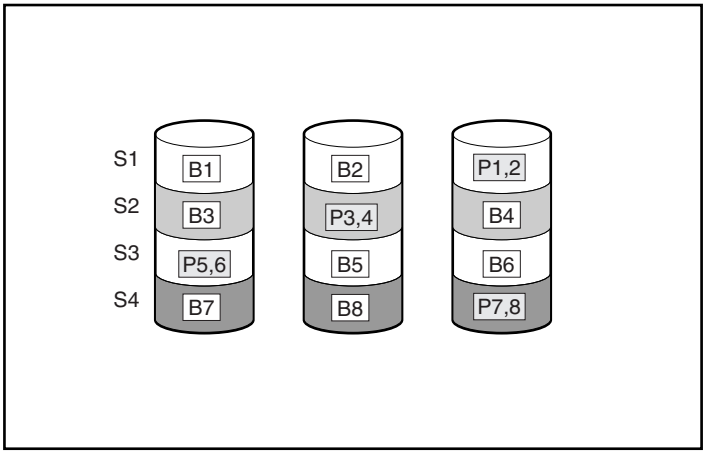


Figure D-7: Distributed data guarding, showing parity information (Px,y)

Advantages

- High read performance
- No loss of data if one physical drive fails
- More drive capacity usable than with RAID 1+0—parity information requires only the storage space equivalent to one physical drive

Disadvantages

- Relatively low write performance
- Loss of data if a second drive fails before data from the first failed drive is rebuilt

RAID ADG—Advanced Data Guarding

RAID ADG is similar to RAID 5 in that parity information is generated (and stored) to protect against data loss caused by drive failure. With RAID ADG, however, two different sets of parity data are used, allowing data to still be preserved if two drives fail. As can be seen in Figure D-8, each set of parity data uses up a capacity equivalent to that of one of the constituent drives.

This method is most useful when data loss is unacceptable, but cost must also be minimized. The probability that data loss will occur when arrays are configured with RAID ADG is less than when they are configured with RAID 5 (for details, refer to Appendix F).

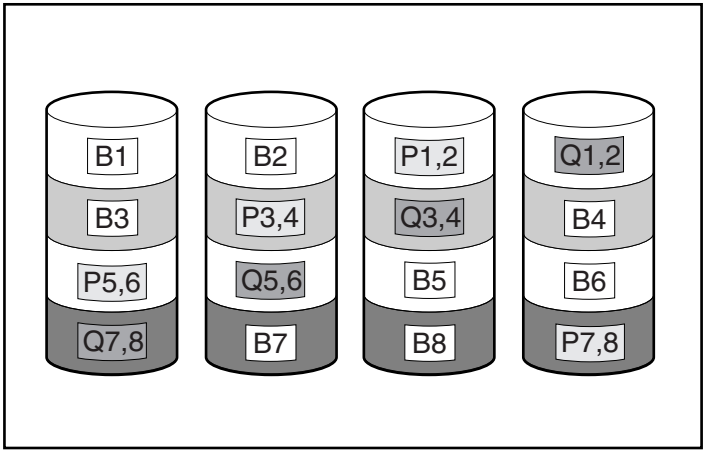


Figure D-8: Advanced data guarding (RAID ADG)

Advantages

- High read performance
- High data availability—any two drives can fail without loss of critical data
- More drive capacity usable than with RAID 1+0—parity information requires only the storage space equivalent to two physical drives

Disadvantage

The only significant disadvantage of RAID ADG is a relatively low write performance (lower than RAID 5), due to the need for two sets of parity data.

Table D-1 summarizes the important features of the different kinds of RAID methods described here. The decision chart in Table D-2 may help you to determine which option is best for your situation.

Table D-1: Summary of RAID Methods

	RAID 0	RAID 1+0	RAID 5	RAID ADG
Alternative name	Striping (no fault tolerance)	Mirroring	Distributed Data Guarding	Advanced Data Guarding
Usable drive space*	100%	50%	67% to 93%	50% to 96%
Usable drive space formula	*n*	*n*/2	(*n*-1)/*n*	(*n*-2)/*n*
Minimum number of physical drives	1	2	3	4
Tolerates failure of one physical drive?	No	Yes	Yes	Yes
Tolerates simultaneous failure of more than one physical drive?	No	Only if no two failed drives are in a mirrored pair	No	Yes
Read performance	High	High	High	High
Write performance	High	Medium	Low	Low
Relative cost	Low	High	Medium	Medium

*Values for usable drive space are calculated with these assumptions: (1) All physical drives in the array have the same capacity; (2) Online spares are not used; (3) No more than 14 physical drives are used per array for RAID 5; (4) No more than 56 drives are used with RAID ADG.

Table D-2: Choosing a RAID Method

Most Important	Also Important	Suggested RAID Level
Fault tolerance	Cost effectiveness	RAID ADG
	I/O performance	RAID 1+0
Cost effectiveness	Fault tolerance	RAID ADG
	I/O performance	RAID 5 (RAID 0 if fault tolerance is not required)
I/O performance	Cost effectiveness	RAID 5 (RAID 0 if fault tolerance is not required)
	Fault tolerance	RAID 1+0

Other Fault-Tolerance Options

Your operating system may also support software-based RAID or controller duplexing.

- **Software-based RAID** resembles hardware-based RAID, except that the operating system works with logical drives as if they were physical drives. To protect against data loss caused by physical drive failure, each logical drive must be in a different array from the others.
- **Controller Duplexing** uses two identical controllers with independent, identical sets of drives containing identical data. In the unlikely event of a controller failure, the remaining controller and drives will service all requests.

However, the hardware-based RAID methods described in this appendix provide a much more robust and controlled fault-tolerant environment. Additionally, controller duplexing and software-based RAID do not support online spares, auto-reliability monitoring, interim data recovery, or automatic data recovery.

If you decide to use one of these alternative fault-tolerance options, configure your arrays with RAID 0 for maximum storage capacity and refer to your operating system documentation for further implementation details.

E

Hard Drive Installation and Replacement

Each SCSI channel on the controller supports up to 14 drives. Drives can be of the Wide Ultra3 or Wide Ultra2 type.

Each drive on a SCSI bus must have a unique ID value in the range 0 to 15 (except ID 7, which is reserved for controller use). This value is set automatically on hot-pluggable drives in Compaq *ProLiant*™ servers and storage systems, but values for other drives must be set manually.

- Do **not** terminate the drives. Compaq servers and internal cabling provide the required termination of the SCSI bus.
- Do **not** use drives of different capacity in the same array. The excess capacity of larger drives cannot be used by the array and is wasted.
- Do **not** use hot-pluggable drives on the same SCSI bus as non-hot-pluggable drives.

Hard drives that are currently supported by Smart Array controllers are listed at www.compaq.com/products/storageworks/.

General Information About Hard Drive Failure

When a hard drive fails, all logical drives that are in the same array will be affected. Each logical drive in an array may be using a different fault-tolerance method, so each logical drive can be affected differently.

- RAID 0 configurations cannot tolerate drive failure. If any physical drive in the array fails, all non-fault-tolerant (RAID 0) logical drives in the same array will also fail.

- RAID 1+0 configurations can tolerate multiple drive failures as long as no failed drives are mirrored to one another.
- RAID 5 configurations can tolerate one drive failure.
- RAID ADG configurations can tolerate simultaneous failure of two drives.

If more hard drives fail than the fault-tolerance method allows, fault tolerance is compromised and the logical drive fails. In this case, all requests from the operating system will be rejected with unrecoverable errors. The "Compromised Fault Tolerance" section discusses possible ways to recover from this situation.

Recognizing Drive Failure

The LEDs on the front of each hard drive are visible through the front of the server or external storage unit. When a drive is configured as a part of an array and attached to a powered-up controller, the status of the drive can be determined from the illumination pattern of these LEDs.

Table E-1 describes the meaning of the various LED combinations.

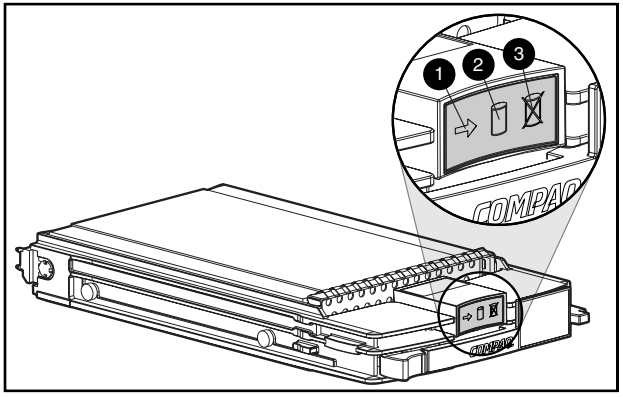


Figure E-1: Hard drive status LED indicators

Table E-1: Hard Drive Status from LED Illumination Pattern

(1) Activity	(2) Online	(3) Fault	Meaning
On, off, or flashing	On or off	Flashing	A predictive failure alert has been received for this drive. Replace the drive as soon as possible.
On, off, or flashing	On	Off	OK to replace the drive online if the array is configured for fault tolerance and all other drives in the array are online. The drive is online and configured as part of an array.
On	Flashing	Off	**Do not remove the drive. Removing a drive during this process may terminate the current operation and cause data loss.** The drive is rebuilding or undergoing capacity expansion.
On	Off	Off	**Do not remove the drive. Removing a drive during this process may cause data loss.** The drive is being accessed, but (1) it is not configured as part of an array; (2) it is a replacement drive and rebuild has not yet started; or (3) it is spinning up during POST.
Flashing	Flashing	Flashing	**Do not remove the drive. Removing a drive during this process can cause data loss in non-fault-tolerant configurations.** Either (1) the drive is part of an array being selected by the Array Configuration Utility; (2) the Options ROMPaq utility is upgrading the drive firmware; or (3) Drive Identification has been selected in Compaq Insight Manager.
Off	Off	On	OK to replace the drive online. The drive has failed and has been placed offline.
Off	Off	Off	OK to replace the drive online if the array is configured for fault tolerance and all other drives in the array are online. Either (1) the drive is not configured as part of an array; (2) the drive is configured as part of an array, but a powered-up controller is not accessing the drive; or (3) the drive is configured as an online spare.

There are several other ways to recognize that a hard drive has failed:

- The amber LED lights up on the front of a Compaq storage system if failed drives are inside. (Other problems such as fan failure, redundant power supply failure, or over-temperature conditions will also cause this LED to light up.)
- A Power-On Self-Test (POST) message lists failed drives whenever the system is restarted, as long as the controller detects one or more good drives. Refer to Appendix G for an explanation of POST messages.
- The Array Diagnostic Utility (ADU) lists all failed drives.

Also, Compaq Insight Manager can detect failed drives remotely across a network.

For additional information about hard drive problems, refer to the *Compaq Servers Troubleshooting Guide*.

Compromised Fault Tolerance

Compromised fault tolerance commonly occurs when more physical drives have failed than the fault-tolerance method can endure. In this case, the logical volume is failed and unrecoverable disk error messages are returned to the host. Data loss is likely to occur.

An example of this situation is where one drive on an array fails while another drive in the same array is still being rebuilt. If the array has no online spare, any logical drives on the array that are configured with RAID 5 fault tolerance will fail.

Compromised fault tolerance may also be caused by non-drive problems, such as temporary power loss to a storage system or a faulty cable. In such cases, the physical drives do not need to be replaced. However, data may still have been lost, especially if the system was busy at the time that the problem occurred.

Procedure to Attempt Recovery

When fault tolerance has been compromised, inserting replacement drives does not improve the condition of the logical volume. Instead, if your screen displays unrecoverable error messages, try the following procedure to recover data.

1. Power down the entire system, and then power it back up. In some cases, a marginal drive will work again for long enough to allow you to make copies of important files.
2. If a 1779 POST message is displayed, press the **F2** key to re-enable the logical volumes. Remember that data loss has probably occurred and any data on the logical volume is suspect.
3. Make copies of important data, if possible.
4. Replace any failed drives.
5. After the failed drives have been replaced, the fault tolerance may again be compromised. If so, cycle the power again. If the 1779 POST message is displayed, press the **F2** key to re-enable the logical drives, recreate your partitions, and restore all data from backup.

To minimize the risk of data loss due to compromised fault tolerance, make frequent backups of all logical volumes.

Automatic Data Recovery

Automatic data recovery is an automatic background process that rebuilds data onto a spare or replacement drive when another drive in the array fails. This process is also called **rebuild.**

If a drive in a fault-tolerant configuration is replaced while the system power is off, a Power-On Self-Test (POST) message is displayed during the next system startup. This message prompts you to press the **F1** key to start automatic data recovery. If automatic data recovery is not enabled, the logical volume remains in a ready-to-recover condition and the same POST message is displayed whenever the system is restarted.

When automatic data recovery has finished, the Online LED of the replacement drive stops blinking and begins to glow steadily.

In general, approximately 15 minutes is required to rebuild each gigabyte. The actual rebuild time depends upon:

- The level of rebuild priority that has been set for the logical drive (refer to Chapter 7 for details)

- The amount of I/O activity occurring during the rebuild operation
- The disk drive speed
- The number of drives in the array (for RAID 5 and RAID ADG)

For example, the rebuild time when using 9-GB Wide-Ultra hard drives in a RAID 5 configuration varies from ten minutes per gigabyte (for three drives) to 20 minutes per gigabyte (for 14 drives).

Failure of Automatic Data Recovery

If the Online LED of the replacement drive stops blinking during automatic data recovery, there are three possible causes:

- If the Online LED is glowing continuously, automatic data recovery was successful and has finished.
- If the amber failure LED is illuminated or other LEDs go out, the replacement drive has failed and is producing unrecoverable disk errors.

  Remove and replace the failed replacement drive.
- If the automatic data recovery process has abnormally terminated, one possible cause is a non-correctable read error on another physical drive. The system may temporarily become operational if rebooted. In any case, locate the faulty drive, replace it, and restore data from backup.

General Aspects of Drive Replacement

Before replacing a degraded drive, use Compaq Insight Manager to examine the error counters recorded for each physical drive in the array to confirm that such errors are not presently occurring. Refer to the Compaq Insight Manager documentation on the Compaq Management CD for details.

CAUTION: Sometimes, a drive that has previously been failed by the controller may seem to be operational after the system is power-cycled, or (for a hot-pluggable drive) after the drive has been removed and reinserted. However, continued use of such marginal drives may eventually result in data loss. Replace the marginal drive as soon as possible.

There are several other factors to remember when replacing a hard drive:

- Non-hot-pluggable drives should only be replaced while the system is powered down.
- Hot-pluggable drives can be removed and replaced at any time, whether the host or storage system power is on or off.

  When a hot-pluggable drive is inserted, all disk activity on the array pauses while the new drive is spinning up (usually 20 seconds or so). If the drive is inserted while power is on, in a fault-tolerant configuration, data recovery onto the replacement drive begins automatically (indicated by the blinking Online LED).
- Replacement drives must have a capacity no less than that of the smallest drive in the array. Drives of insufficient capacity will be failed immediately by the controller before automatic data recovery can begin.
- When you set the SCSI ID jumpers manually, check the ID value to be sure that the correct physical drive is being replaced. Set the same ID value on the replacement drive to prevent SCSI ID conflicts.

CAUTION: In systems using external data storage, take care that the server is the first unit to be powered down and the last to be powered back up. Doing this ensures that the system will not erroneously mark the drives as failed.

The rebuild operation takes several hours, even if the system is not busy while the rebuild is in progress. System performance and fault tolerance are both affected until the rebuild has finished. Therefore, replace drives during low activity periods whenever possible. In addition, be sure that all logical volumes on the same array as the drive being replaced have a current, valid backup.

Drive Failure During Rebuild

If another drive in the array fails while fault tolerance is unavailable during rebuild, a fatal system error may occur. If this happens, all data on the array is lost. In exceptional cases, however, failure of another drive need not lead to a fatal system error. These exceptions include:

- Failure after activation of a spare drive

- Failure of a drive that is not mirrored to any other failed drives (in a RAID 1+0 configuration)
- Failure of a second drive in a RAID ADG configuration

Minimizing Fatal System Errors During Rebuild

When a hard drive is replaced, the controller gathers fault-tolerance data from the remaining drives in the array. This data is then used to rebuild the missing data (originally on the failed drive) onto the replacement drive. If more than one drive is removed at a time, the fault-tolerance data is incomplete. The missing data cannot then be reconstructed and is likely to be permanently lost.

To minimize the likelihood of fatal system errors, take these precautions when removing failed drives:

- Do not remove a degraded drive if any other member of the array is offline (the Online LED is off). In this condition, no other drive in the array can be removed without data loss.

  There are some exceptions:

  — When RAID 1+0 is used, drives are mirrored in pairs. Several drives can be in a failed condition simultaneously (and they can all be replaced simultaneously) without data loss, as long as no two failed drives belong to the same mirrored pair.

  — When RAID ADG is used, two drives can fail simultaneously (and be replaced simultaneously) without data loss.

  — If an online spare has an unlit Online LED (it is offline), the degraded drive can still be replaced.

- Do not remove a second drive from an array until the first failed or missing drive has been replaced **and** the rebuild process is complete. (When the rebuild is complete, the Online LED on the front of the drive stops blinking.)

  There are some exceptions:

  — In RAID ADG configurations, any two drives in the array can be replaced simultaneously.

— In RAID 1+0 configurations, any drives that are not mirrored to other removed or failed drives can be simultaneously replaced offline without data loss.

Moving Drives and Arrays

You can move drives to other ID positions on the same array controller. You can also move a complete array from one controller to another (even if the controllers are on different servers). However, if you combine arrays that were on different controllers into one larger array on a single controller, the data on the arrays is lost.

Before moving drives, these conditions must be met:

- The move will not result in more than 14 physical drives per channel.
- No more than 32 logical volumes will be configured for a controller.
- No drives are failed or missing.
- The array is in its original configuration with no active spare drives.
- Capacity expansion is not running.
- Controller firmware is the latest version (recommended).

If moving an array, all drives in the array must be moved at the same time.

IMPORTANT: There are some restrictions on moving an array:

- A drive array that has been moved from a battery-backed array controller to one that is not battery-backed can no longer undergo RAID/stripe size migration, array capacity expansion, or logical drive capacity extension.
- Do not move an array that is configured with RAID ADG to a controller that does not support RAID ADG. Only controllers that support RAID ADG can recognize a drive array that has this configuration.

When the conditions have been met:

1. Back up all data before removing any drives or changing configuration. This step is **required** if you are moving data-containing drives from a controller that is not battery backed.

2. Power down the system.
3. Move the drives.
4. Power up the system.

   A 1724 POST message is displayed, indicating that drive positions were changed and the configuration was updated.

> **CAUTION:** If a 1785 (Not Configured) POST message is displayed, power the system down immediately to avoid data loss, and then return the drives to their original locations.

5. Restore the data from backup if necessary.

You can now check the new drive configuration by running ORCA or the Array Configuration Utility (refer to Chapter 7 for details).

Upgrading Hard Drive Capacity

You can increase the storage capacity on a system by swapping drives one at a time for higher capacity drives. This method is viable as long as a fault-tolerance method is running, and can be done even if there are no available drive bays.

> **CAUTION:** Since a data rebuild takes about 15 minutes per gigabyte, your system is unprotected against drive failure for many hours, or even days, while the rebuild is in progress.

To upgrade hard drive capacity:

1. Back up all data.
2. Replace any drive. The data on the new drive is re-created from redundant information on the remaining drives.

   > **CAUTION:** Do not replace any other drive until data rebuild on this drive is complete.

3. When data on the new drive has been rebuilt (the Activity LED is no longer illuminated), repeat the previous step for the other drives in the array, one at a time.

When all drives have been replaced, you can use the extra capacity to create new logical drives or extend existing logical drives.

Expanding and Extending Capacity

Array capacity expansion is the addition of physical drives to an array and the redistribution of the pre-existing logical drives over the enlarged array.

The expansion process is illustrated in Figure E-2, where the original array (containing data) is shown with a dashed border, and the newly added drives are shown unshaded (containing no data). The array controller adds the new drives to the array and redistributes the original logical drives over the enlarged array, one logical drive at a time. Each logical drive keeps the same fault-tolerance method in the enlarged array that it had in the smaller array.

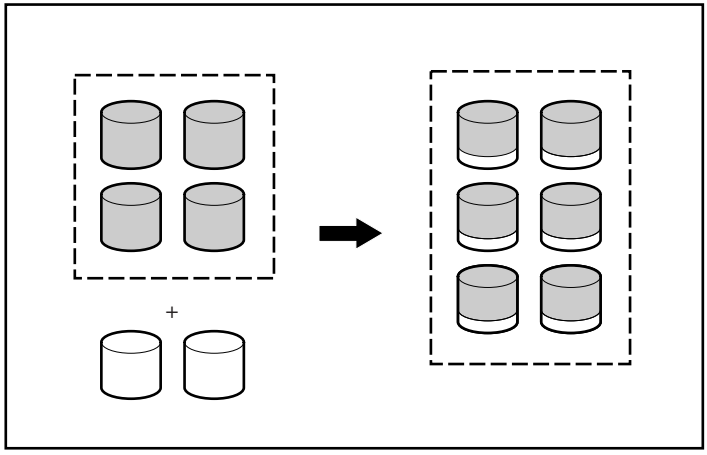


Figure E-2: Array capacity expansion

The unused capacity on the enlarged array can now be used to create an additional logical drive, with a different fault-tolerance setting if necessary.

Alternatively, the unused capacity can be used to increase the size of one of the original logical drives; this process is **logical drive capacity extension**. Another method for carrying out logical drive capacity extension is to delete an existing logical drive and then to add the freed capacity to another logical drive.

Capacity expansion is carried out using one of the utilities described in Chapter 7. For reconfiguration to occur online (that is, without shutting down the operating system), the configuration utility must be running in the same environment as the normal server applications. Also, online expansion is possible only in systems that are using hot-pluggable drives.

Only ACU and ACU-XE support capacity extension. Also, not all operating systems allow extension to be carried out while the system is online (refer to Chapter 7 for details).

F

Probability of Logical Drive Failure

The probability that a logical drive will fail depends on the RAID level setting.

- A RAID 0 logical drive fails if only one physical drive fails.
- For a RAID 1+0 logical drive, the failure situation is complex.
  - The **maximum** number of physical drives that can fail without causing failure of the logical drive is *n*/2, where *n* is the number of hard drives in the array. This maximum is reached only if no failed drive is mirrored to any other failed drive. In practice, a logical drive usually fails before this maximum is reached. As the number of failed drives increases, it becomes increasingly unlikely that a newly failed drive is not mirrored to a previously failed drive.
  - The failure of **only two** physical drives is enough to cause a logical drive to fail **if** the two drives happen to be mirrored to each other. The risk of this occurring decreases as the number of mirrored pairs in the array increases.
- A RAID 5 logical drive (with no online spare) fails if two physical drives fail.
- A RAID ADG logical drive (with no online spare) fails when three physical drives fail.

At any given RAID level, the probability of logical drive failure increases as the number of physical drives in the logical drive increases.

The graph in Figure F-1 provides more quantitative information. The data for this graph is calculated from the mean time between failure (MTBF) value for a typical physical drive, assuming that no online spares are present. If an online spare is added to any of the fault-tolerant RAID configurations, the probability of logical drive failure is further decreased.

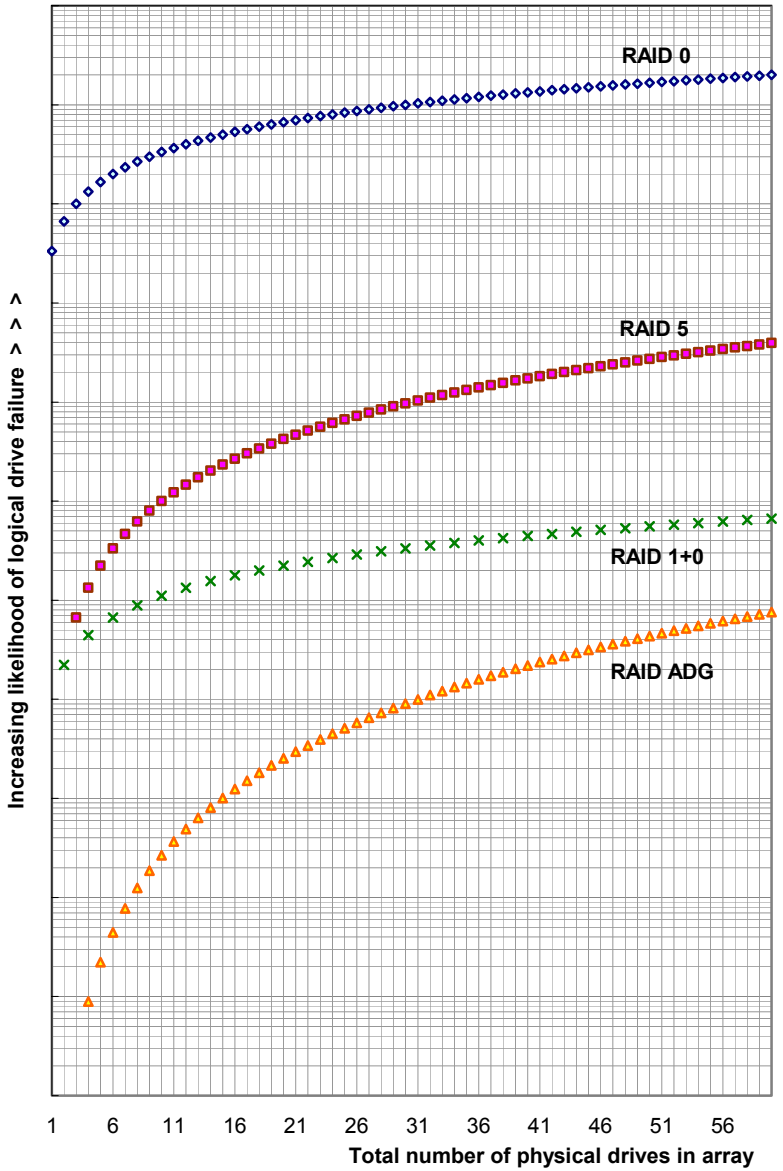


Figure F-1: Relative probability of logical drive failure

G

POST Error Messages

Smart Array controllers produce diagnostic error messages at reboot. Many of these Power-On Self-Test (POST) messages are self-explanatory and suggest corrective actions for troubleshooting. Detailed information about these messages is given in Table G-1.

Table G-1: POST Error Messages

Message	Description	Meaning and Recommended Action
1702	SCSI cable error detected. System halted.	There is a termination or cabling problem with the system board integrated SCSI controller. See the cabling information in this guide.
1711	Slot x drive array – RAID ADG logical drives present but cache size is less than or equal to 32 MB.	This configuration is not recommended. Migrate the logical drive (or drives) to RAID 5 or upgrade the array accelerator cache module.
1712	Slot x drive array – RAID 5 logical drives present with 56 drives or more, but cache size is less than or equal to 32 MB.	This configuration is not recommended. Migrate the logical drive (or drives) to RAID 0 or 1, reduce the number of drives in the array, or upgrade the array accelerator cache module.
1713	Slot x drive array – Redundant ROM reprogramming failure.	Replace the controller if this error persists after restarting the system.
1714	Slot x drive array – Redundant ROM checksum error.	Backup ROM has been activated automatically. Check the firmware version.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1720	Slot x drive array – S.M.A.R.T. hard drive detects imminent failure: SCSI port x: SCSI ID y	The indicated drive has reported a S.M.A.R.T. predictive-failure condition. It may fail at some time in the near future. **Do not replace the drive unless all other drives on the array are online!** Back up data before replacing drive(s).
1721	Slot x drive array – drive parameter tracking predicts imminent failure The following device(s) should be replaced when conditions permit: (a list of devices will be given here).	**Do not replace the drive unless all other drives on the array are online!** Back up data before replacing drive(s). M&P predictive failure threshold exceeded condition. The indicated drive(s) may fail at some time in the near future.
1723	Slot x drive array – to improve signal integrity, internal SCSI connector should be removed if external drives are attached to the same SCSI port (followed by further details).	Follow the remaining instructions in the POST message.
1724	Slot x drive array – physical drive position change(s) detected – logical drive configuration has automatically been updated.	Logical drive configuration has been updated automatically following physical drive position changes. Press the **F1** key to resume.
1726	Slot x drive array – array accelerator memory size change detected – array accelerator configuration has automatically been updated	This message is displayed if the controller is replaced with a model that has a different amount of cache memory.
1727	Slot x drive array – new logical drive(s) attachment detected (if >32 logical drives, this message will be followed by **Auto-configuration failed: too many logical drives**)	The controller has detected an additional array of drives that was attached when the system was powered down. The logical drive configuration information has been updated to add the new logical drives. The maximum number of logical drives supported is 32 – additional drives will not be added to the configuration if this number is exceeded. Press the **F1** key to resume.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1728	Slot x drive array – abnormal shutdown detected with write cache enabled. No array accelerator battery backup on this model array controller. Any data that may have been in array accelerator memory has been lost.	This message should never occur unless the write cache is somehow enabled on a controller that does not have batteries.
1729	Slot 1 drive array – disk performance optimization scan in progress – RAID 4/5 performance may be higher after completion.	This message is normal after the initial configuration of RAID 4 or RAID 5 logical drives. After the parity data has been initialized by ARM (an automatic process that runs in the background on the controller), this message goes away and controller performance improves.
1753	Slot x drive array – array controller maximum operating temperature exceeded during previous power up.	This message appears at the next power-up if the controller locks due to excessive temperature. Check for proper operation of the server cooling fan.
1754	Slot z drive array – RAID ADG drive(s) configured but ADG Enabler Module is detached or defective. Please check for detached ADG Enabler Module. Array accelerator is temporarily disabled.	An operational ADG Enabler Module must be attached whenever RAID ADG volumes are configured or the array accelerator will be disabled. Replace the ADG Enabler Module.
1755	Slot z drive array – ADG Enabler Module appears to be defective. Please replace the ADG Enabler Module.	Replace the defective ADG Enabler Module, or remove it if it is not needed (that is, if no RAID ADG logical drives are configured).
1756	Slot x redundant controllers are not the same model.	The redundant controllers are not of the same model. Use two like model controllers for redundancy.
1757	Slot x array accelerator daughterboard incompatible. Please replace 4MB array accelerator card with a 16MB or 64MB card.	The controller does not support the attached array accelerator. Replace it with the correct array accelerator.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1758	Slot x drive array – array accelerator size mismatch between controllers. 64MB array accelerator should be attached to both controllers.	The size of the array accelerators is different between two controllers in a redundant controller configuration. Use array accelerators of the same size on both controllers.
1759	Slot x drive array – redundant controller error	Replace controller or server system board.
1762	Redundant controller operation is not supported in this firmware version. Please remove redundant controller or upgrade controller firmware. (Controller is disabled until this problem is resolved.)	Remove the redundant controller or visit the Compaq website and get the latest upgrade for the controller firmware.
1763	Array accelerator daughtercard is detached; please reattach. (Controller is disabled until this problem is resolved.)	This controller model cannot operate if the array accelerator is detached. Reattach the array accelerator.
1764	Slot x drive array – capacity expansion process is temporarily disabled (followed by a cause).	The capacity expansion process has been temporarily disabled for the reason indicated and will automatically resume. If the array accelerator has been removed, you must reinstall it for capacity expansion to continue.
1765	Slot x drive array Option ROM appears to conflict with an ISA card – ISA cards with 16-bit memory cannot be configured in memory range C0000 to DFFFF along with SMART-2/E 8-bit Option ROM due to EISA buffer limitations. Please remove or reconfigure your ISA card.	Remove or reconfigure the conflicting ISA card, referring to the directions provided with the ISA card. Alternatively, the Option ROM can be disabled on the SMART-2/E controller through the System Configuration Utility if a SMART-2/E is not the primary (boot) controller.
1766	Slot x drive array requires System ROM upgrade. Run System ROMPaq Utility.	Run the latest version of the System ROMPaq utility.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1768	Slot x drive array – resuming logical drive expansion process.	No action required. This message appears whenever a controller reset or power cycle occurs while array expansion is in progress.
1769	Slot x drive array – drive(s) disabled due to failure during expansion (possibly followed by additional details).	Data has been lost while expanding the array; therefore, the drives have been temporarily disabled. Press the **F2** key to acknowledge the data loss and re-enable the logical drives. Restore data from backup. If the array accelerator has failed, replace the array accelerator board after the capacity expansion process has terminated. **Never** turn off the system and replace the array accelerator board if capacity expansion is in progress.
1770	Slot x drive array – critical drive firmware problem detected – please upgrade firmware on the following drive(s) using Options ROMPaq (available from www.compaq.com): SCSI port (y) SCSI ID (*x*)	The indicated drives are running firmware that may cause intermittent problems. Use the Options ROMPaq utility to upgrade firmware on all drives to the latest revision.
1774	Slot x drive array – obsolete data found in array accelerator. Data found in accelerator was older than data found in drives. Obsolete data has been discarded.	Data found on the array accelerator is older than data found on drives due to drives having been disconnected, used on another controller, and then reconnected. Press the **F1** key to discard older data.
1775	Slot x drive array – ProLiant storage system not responding SCSI port (y): Check storage system power switch and cables. Power the system down while checking the ProLiant power and cable connections, then power the system back up to retry.	Power the system down. Check the external ProLiant power switch—external drives must all be powered up before or at the same time as the main system. Check cables. If retrying does not help, update the ProLiant System firmware, or try replacing the cable, ProLiant storage backplane, or the array controller.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1776	Slot x drive array – SCSI bus termination error – internal and external drives cannot both be attached to the same SCSI port. SCSI port (y): Check cables.	The internal and external connectors of the specified SCSI port(s) are both attached to drives. The SCSI bus is not properly terminated when internal and external drives are attached concurrently to the same SCSI bus. The indicated SCSI bus is disabled until this problem is resolved. Turn off the server power and check the cabling to the specified SCSI port.
1777	Slot x drive array – ProLiant drive storage enclosure problem detected (followed by one or more of the following): • SCSI port (y): Cooling fan malfunction detected • SCSI port (y): Overheated condition detected • SCSI port (y): Side-panel must be closed to prevent overheating • SCSI port (y): Redundant power supply malfunction detected • SCSI port (y): Wide SCSI transfer failed • SCSI port (y): Interrupt signal inoperative • Check SCSI cables.	Check the cooling fan operation by placing your hand over the fan. Check the internal plenum cooling fan in tower servers or storage systems. If the fan is not operating, check for obstructions and check all internal connectors. Replace the unit side panel, if it was removed. When the ProLiant Storage System power LED is amber instead of green, the following conditions may be present: • A fan failure • A redundant power supply failure • A thermal problem If the message directs you to check SCSI cables, check your cabling against the diagrams in this user guide. If the routing is correct, replace cables on the specified port until the POST message is eliminated.
1778	Slot x drive array resuming Automatic Data Recovery process.	No action required. This message appears whenever a controller reset or power cycle occurs while Automatic Data Recovery is in progress.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1779	Slot x drive array – replacement drive(s) detected **or** previously failed drive(s) now appear to be operational: Port (y): SCSI ID (x) Restore data from backup if replacement drive x has been installed.	If this message appears and drive *x* has not been replaced, an intermittent drive failure has occurred. This message also appears once immediately following drive replacement before data is restored from backup.
1783	Slot x drive array controller failure.	If this message appears immediately following a ROM installation, the ROM is either defective or not installed properly. Check that the controller is firmly inserted in its slot. Check for improper cabling or SCSI ID conflicts. Try upgrading the system ROM. Otherwise, replace the array controller.
1784	Slot x drive array drive failure. The following SCSI drive(s) should be replaced: SCSI port (y) SCSI ID (x)	Check for loose cables. Replace defective drive *x* and/or cable(s).

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1785	Slot 1 Drive Array not Configured (may be followed by one of the following messages): (1) No drives detected (2) Drive positions appear to have changed. Run the Array Diagnostics Utility (ADU) if previous positions are unknown, then turn system power OFF and move drives to their original positions. (3) Configuration information indicates drive positions beyond the capability of this controller. This may be due to drive movement from a controller that supports more drives than the current controller. (4) Configuration information indicates drives were configured on a controller with a newer firmware version.	(1) Turn off the system and check SCSI cable connections to be sure that drives are attached properly. (2) Run the Array Diagnostics Utility (ADU) if previous positions are unknown. Then power the system down and move drives to their original positions. (3) To avoid data loss, power the system down and reattach drives to the original controller. (4) To avoid data loss, reattach drives to the original controller or upgrade the controller firmware to the version on the original controller using the Options ROMPaq utility. Press the **F1** key to resume.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1786	Slot x Drive Array Recovery Needed. The following SCSI drive(s) need Automatic Data Recovery: SCSI port (*y*): SCSI ID (*x*) Select **F1** to continue with recovery of data to drive(s). Select **F2** to continue without recovery of data to drive(s). **-or-** Slot x drive array recovery needed. Automatic Data Recovery previously aborted! The following SCSI drive(s) need Automatic Data Recovery (rebuild): SCSI port (*y*): SCSI ID (*x*) Select **F1** to retry Automatic Data Recovery to drive. Select **F2** to continue without starting Automatic Data Recovery.	The message normally appears when a drive is replaced in a fault-tolerant configuration when the system is powered down. In this case, press the **F1** key to start the automatic data recovery process. A 1786 POST message will appear if the previous rebuild attempt was aborted for any reason. Run the Array Diagnostics Utility (ADU) for more information. If the replacement drive was failed, try using another replacement drive. If rebuild was aborted due to a read error from another physical drive in the array: 1. Back up all readable data on the array. 2. Run Diagnostics Surface Analysis. 3. Restore your data.
1787	Slot x drive array operating in Interim Recovery Mode. The following SCSI drive(s) should be replaced: SCSI port (y): SCSI ID (x)	Following a system restart, this message reminds you that drive *x* is defective and fault tolerance is being used. Replace drive *x* as soon as possible. A loose or defective cable may also cause this error.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1788	(1) Slot x drive array reports incorrect drive replacement. The following SCSI drive(s) should have been replaced: SCSI port (y): SCSI ID (x). The following SCSI drive(s) were incorrectly replaced: SCSI port (y): SCSI ID (z). Select **F1** to continue – drive array will remain disabled. Select **F2** to reset configuration – all data will be lost. **-or-** (2) Faulty power cable connection to the drive. **-or-** (3) Defective SCSI cable.	(1) The drives indicated were installed in the wrong place, so they have been disabled. Reinstall the drives correctly. Press the **F1** key to restart the computer with the drive array disabled. **-or-** Press the **F2** key to use the drives as configured and lose all the data on them. (2) Repair the connection and press the **F2** key. If pressing the **F2** key does not eliminate this message, run the Array Diagnostics Utility (ADU). (3) Contact your Compaq authorized service provider.
1789	Slot x drive array physical drive(s) not responding. Check cables or replace the following SCSI drives: SCSI port (y): SCSI ID (x) Select **F1** to continue – drive array will remain disabled. Select **F2** to fail drives that are not responding – Interim Recovery Mode will be enabled if configured for fault tolerance.	This message indicates that previously operating drives are missing or inoperative following a cold or warm reset. Turn off the system and check cable connections. If the cables are connected, replace the drive. Press the **F1** key to restart the computer with the drive array disabled. **-or-** If you do not want to replace the drives now, press the **F2** key.
1792	Slot x valid data found in array accelerator. Data automatically written to drive array.	Power was interrupted while the system was in use, or the system was restarted while data was in the array accelerator memory. Power was restored within four days.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1793	Slot x drive array – array accelerator battery depleted. Data in array accelerator has been lost. (Error message 1794 is also displayed.)	While the system was in use, power was interrupted while data was in the array accelerator memory. Power was not restored within four days, so the batteries were depleted and data in the array accelerator was lost. Check all files for potential data corruption. **-or-** The array accelerator batteries have failed.
1794	Slot x drive array – array accelerator battery charge low. Array accelerator is temporarily disabled. Array accelerator will be re-enabled when battery reaches 90% charge. If the battery pack has failed, this message will also be displayed: Array accelerator batteries have failed to charge and should be replaced (Compaq spares #120978-001)	The battery charge is below 90%. Posted writes are disabled. When the batteries are fully recharged, the array accelerator will automatically be re-enabled and this POST message will go away. Replace the array accelerator or array controller if batteries do not recharge within 36 hours after powering up. If the battery pack has failed, replace the battery pack.
1795	Slot x drive array – array accelerator configuration error. Data does not correspond to this drive array. Array accelerator is temporarily disabled.	The data stored on the array accelerator does not correspond to this drive array. Match the array accelerator to the correct drive array. **-or-** Run the System Configuration Utility to clear data on the array accelerator.
1796	Slot x drive array – array accelerator is not responding. Array accelerator is temporarily disabled.	Replace the array accelerator or the Smart Array controller.
1797	Slot x drive array – array accelerator read error occurred. Data in array accelerator has been lost. Array accelerator is disabled.	Replace the array accelerator or the Smart Array controller. Restore data from backup.

continued

Table G-1: POST Error Messages *continued*

Message	Description	Meaning and Recommended Action
1798	Slot x drive array – array accelerator write error occurred. Array accelerator is disabled.	Replace the array accelerator or the Smart Array controller. Restore data from backup.
1799	Slot x drive array – drive(s) disabled due to array accelerator data loss. Select **F1** to continue with logical drives disabled. Select **F2** to accept data loss and re-enable logical drives.	Data stored in the array accelerator has been lost; therefore, the drives have been temporarily disabled. Press the **F2** key to acknowledge the data loss and re-enable the logical drives. Restore data from backup.

H

Questions and Answers

Q: How many Smart Array 5300 Controllers can I install in my system?

A: The maximum number of controllers that you can install in your system depends on your server and several other factors specific to your configuration. Generally, the maximum number is restricted to the number of PCI slots not used for other peripherals.

Another limiting factor is the power rating of your system. Each Smart Array 5300 Controller requires 21.2 W (or 24.9 W if it has four channels). Your server must be capable of supplying every controller with this amount of power.

Q: How many internal and external drives can I install in my system?

A: Each Smart Array 5300 Controller has two SCSI buses (one internal and up to two external), upgradeable to four SCSI buses (two internal and up to four external). Each bus can support up to 14 drives.

Your choice of server and the hard drive heights also affect the maximum number of internal and external drives that you can install in your system.

Q: Does the Smart Array 5300 Controller support SCSI tape drives and CD-ROM drives?

A: The Smart Array 5300 Controller supports the Compaq Universal Hot Plug Tape Drive. However, it does not support any CD-ROM drives.

Q: I installed the hard drives in my server. Must I now terminate each drive?

A: No. If you installed hard drives in a server with a Smart Array controller, the I/O board and the hot-plug backplane in the server meet all termination requirements. Individual hot-pluggable drives should already have termination removed.

Q: What is the data transfer rate for Wide Ultra3 SCSI?

A: Wide Ultra3 SCSI has a data bandwidth of 160 MB per second. Most server applications do not generally take advantage of the full Ultra3 bandwidth, so performance results will vary from customer to customer.

Q: What is the difference between LVD and Ultra3 SCSI?

A: Low Voltage Differential (LVD) is a signaling level for SCSI protocols. Ultra3 is a SCSI protocol that uses LVD signaling. Ultra2 also uses LVD signaling, but earlier SCSI protocols used Single-Ended (SE) signaling.

Q: Are Single Ended and Low Voltage Differential SCSI compatible?

A: Yes. When mixing SE drives and LVD drives on a single SCSI channel, all drives switch down to SE SCSI mode and operate under SE SCSI rules. To maintain a true LVD SCSI bus with its associated performance advantages, a LVD SCSI channel should only be connected to LVD SCSI drives.

Q: I have several hard drives in my server and in a Compaq StorageWorks Enclosure 4300. What SCSI IDs do I assign for these drives?

A: If you are using hot-pluggable drives in a StorageWorks Enclosure 4300, the SCSI IDs are set **automatically** according to the bay in which the drives are installed and do not need to be set manually.

If you are using non-hot-pluggable drives in a ProLiant server, you must set the SCSI ID jumpers manually. Each hard drive must have a unique SCSI ID for each controller port.

The IDs of devices on each SCSI bus do not have to be consecutive. However, the IDs must still be unique to each device on any given SCSI bus.

Q: I am planning to install several hard drives in my Compaq servers. Can I install each drive in any drive bay?

A: Yes, you may install these drives in any drive bay; they do not need to be installed in contiguous bays.

Q: I ordered my server with a pre-installed Smart Array controller. How do I order cables to connect to my Compaq external storage enclosure?

A: The required cable is supplied with the external storage enclosure. If you lose or misplace an external cable, see the cable information in this guide, or refer to the cable guide on the Compaq website for a complete listing of correct cables for your array controller and enclosure.

Q: I do not have any hard drives in my server, but I am connecting it to a Compaq StorageWorks Enclosure 4300, which has several hard drives. Which SCSI port do I use?

A: If you have **no** hard drives installed in your server, you can connect the StorageWorks Enclosure 4300 to either of the available external ports (SCSI connectors).

If your server has hard drives installed, you must connect the StorageWorks Enclosure 4300 to the unused port on the controller. You cannot connect devices to both the internal and external connectors of the same port.

Q: How do I interpret a POST error message referring to the Smart Array Controller?

A: Write down the POST error message and refer to Appendix G, "POST Error Messages," for detailed information. If you still do not know what to do, run the Array Diagnostics Utility.

Q: Can I use third-party drives (those not manufactured by Compaq) on the Smart Array controller?

A: Yes. However, experience in Compaq testing laboratories reveals that you might have problems such as time-outs or data corruption. The Smart Array controller takes full advantage of tagged-command queuing, something that can be a problem in the firmware of many third party drives.

Also, Compaq offers a unique Pre-Failure Warranty for all drives—valid only when using Compaq drives, Compaq array controllers, and Compaq Insight Manager. Contact your dealer for more information about the Compaq Pre-Failure Warranty.

Q: Why do the drive activity LEDs light up on some drives when my system is idle?

A: The Smart Array controller performs several different background activities on the drives when the controller is otherwise idle. For example, Auto-Reliability Monitoring scans fault-tolerant volumes for defects and verifies the consistency of parity data, and Drive Parameter Tracking periodically checks the performance of all drives on the controller (normally on an hourly basis).

Q: What is RAID ADG?

A: RAID ADG is an extension of RAID 5 that allows additional fault tolerance by using two different and independent parity schemes. Data is striped across a set of hard drives, just as with RAID 5, and the two sets of parity data are calculated and written across all the drives in the array.

RAID ADG provides an extremely high level of fault tolerance and can sustain two simultaneous drive failures without downtime or data loss. This fault tolerance level is the perfect solution when data is mission critical.

Not all controllers support RAID ADG.

Q: How is RAID ADG activated?

A: RAID ADG is activated by means of a software key that you install on the controller. This software key is available as a separate option kit, and it is suitable for all model SA5304 controllers.

Older versions of the Smart Array 5304 Controller also allow you to activate RAID ADG by using a hardware key (the RAID ADG Enabler Module) and a firmware upgrade.

Glossary

ACU (Array Configuration Utility)
A configuration utility useful both for novices and for more experienced RAID users. Obtained either from the SmartStart CD or as a download from the Compaq website.

ADU (Array Diagnostic Utility)
A diagnostic tool that collects comprehensive information about the array controllers in a system and lists any problems detected.

ARM (Auto-Reliability Monitoring)
Also known as surface analysis. A fault management feature whereby hard drives are scanned for bad sectors, and data in the faulty sectors is remapped onto good sectors. Parity data consistency is also checked for drives in RAID 5 or RAID ADG configurations. Operates as a background process.

array
A set of physical drives configured into one or more logical drives. Arrayed drives have significant performance and data protection advantages over non-arrayed drives.

array accelerator
A component of some Smart Array controllers that dramatically improves disk read and write performance by providing a buffer. Data integrity is protected by a backup battery and ECC memory.

array capacity expansion
See capacity expansion.

Automatic Data Recovery
Also known as rebuild. A process that automatically reconstructs data from a failed drive and writes it onto a replacement drive. Rebuild time depends on several factors, but at least 15 minutes should be allowed per gigabyte.

cache
A high-speed memory component, used to store data temporarily for rapid access.

capacity expansion
Abbreviation for array capacity expansion. The addition of physical drives to a pre-existing drive array, and redistribution of existing logical drives and data over the enlarged array. The size of the logical drives does not change. This feature is available only with Compaq array controllers that have a battery-backed array accelerator installed.

capacity extension
Abbreviation for logical drive capacity extension. The enlargement of a logical drive without disruption of data. There must be free space on the array before extension can occur. If necessary, create free space by deleting a logical drive or by carrying out a capacity expansion. Capacity extension can be carried out online with some operating systems.

controller duplexing
A type of fault tolerance that requires two Smart Array controllers. Each controller has its own set of drives, and the drive sets have identical data. When one controller fails, the other automatically takes over the servicing of requests. Controller duplexing is available only for some operating systems.

Compaq Insight Manager
A server management utility capable of collecting, analyzing and transmitting data about the condition of a server. It is also useful for managing server fault conditions, monitoring server performance, and remotely controlling, reconfiguring, or restarting your system.

Compaq Management Agents
Server-based software that transmits data about the server to SNMP-based management tools, such as Compaq Insight Manager.

CPQONLIN
An array configuration utility for NetWare that can be used while the server is online.

data guarding
See RAID**.**

data striping
Writing data to logical drives in interleaved chunks (by byte or by sector). This technique improves system performance.

drive mirroring
See RAID**.**

ECC (error correction and checking) memory
A type of memory that checks and corrects single-bit or multi-bit memory errors (depending on configuration) without causing the server to halt or corrupt data.

fault tolerance
The ability of a server to recover from hardware problems without interrupting server performance or corrupting data. Hardware RAID is most commonly used, but there are other types of fault tolerance—for example, controller duplexing and software-based RAID.

flashing
Updating the flash memory on a system. Flash memory is non-volatile memory that is used to hold control code such as BIOS information. It is also very fast because it can be rewritten block by block, rather than byte by byte.

hot spare
See online spare.

logical drive (or **logical volume)**
A group of physical drives, or part of a group, that behaves as one storage unit. Each constituent physical drive contributes the same storage volume to the total volume of the logical drive. Has performance advantages over individual physical drives.

logical drive capacity extension
See capacity extension.

LVD (low voltage differential)
A type of SCSI signaling that allows a maximum transfer rate of either 80 MB/s or 160 MB/s, conforming to either the Wide Ultra2 or Wide Ultra3 SCSI standards respectively.

online spare
Also known as a hot spare, this is a drive in a fault-tolerant system that normally contains no data. When any other drive in the array fails, the controller automatically rebuilds the missing data that was on the failed drive onto the online spare. The controller constructs the missing data from the duplicate or parity data that is on the remaining drives in the array.

ORCA (Option ROM Configuration for Arrays) utility
A ROM-based configuration utility for users who have simple configuration requirements.

PCI-X
An enhanced PCI bus that allows operation at 133 MHz, equivalent to a data throughput of 1.0 GB/s. PCI-X is backward-compatible with PCI systems and devices, which operate at 66 MHz or 33 MHz.

POST (Power-On Self-Test)
A series of diagnostic tests that run automatically each time the server is started or reset.

RAID (Redundant Array of Independent Disks)
A form of fault tolerance. **RAID 0** (no fault tolerance) uses data striping to distribute data evenly across all physical disks in the array, but has no redundant data. **RAID 1+0** (drive mirroring) duplicates data from one drive onto a second drive. **RAID 5** (distributed data guarding) distributes parity data across all drives in the array, and uses the parity data and data on remaining drives to reconstruct data from a failed drive. **RAID ADG** (advanced data guarding) is similar to RAID 5, but uses two independent sets of parity data. Refer to Appendix D for more details.

rebuild
See Automatic Data Recovery.

ROMPaq utility
A utility for updating the system or option firmware, available on the SmartStart CD or from the Compaq website. The system must support flashing to be able to take advantage of the ROMPaq utility.

SCSI ID
A unique ID number assigned to each SCSI device connected to a SCSI bus. The ID number determines the device priority on the SCSI bus; ID 7 is the highest priority and is always assigned to the SCSI controller.

SE (single-ended)
A type of SCSI signaling that allows a maximum transfer rate of 40 MB/s. Conforms to the Wide-Ultra SCSI standard. Now being phased out in favor of LVD technology.

S.M.A.R.T. (Self-Monitoring, Analysis, and Reporting Technology)
Technology co-developed by Compaq and the hard drive industry that provides warning of imminent drive failure. This feature makes it possible for Compaq to offer Pre-Failure Warranty replacement of hard drives. S.M.A.R.T. supersedes the drive parameter tracking feature that was previously used for this purpose because the self-monitoring routines used in S.M.A.R.T. are more accurate than the drive parameter tracking tests. The self-monitoring routines are customized for that specific drive type and have direct access to internal performance, calibration, and error measurements.

SmartStart
An abbreviation for the Compaq SmartStart and Support Software CD. A collection of software for updating system drivers, configuring arrays or a system, diagnosing problems with arrays or a system, and updating firmware for the system or options. (The latest version of any of these software packages can be obtained by downloading a SoftPaq file from the Compaq website.) SmartStart can also be used to create or update the system partition on your hard drive.

SNMP (Simple Network Management Protocol)
Governs network management and the monitoring of network devices and functions.

SoftPaq file
A compressed, self-extracting executable file available on the Compaq website that contains the latest version of a particular support software package. Can be downloaded to diskettes or directly to a hard drive.

spare
See online spare.

striping
See data striping.

surface analysis
See ARM.

VHDCI (Very High Density Cable Interconnect)
A type of external SCSI connector used by Ultra SCSI controllers.

Wide-Ultra; Wide Ultra2; Wide Ultra3
A set of SCSI standards that support maximum signal transfer rates of 40 MB/s, 80 MB/s, and 160 MB/s, respectively.

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